
Association of American Railroads

1967

ADVANCE REPORTS

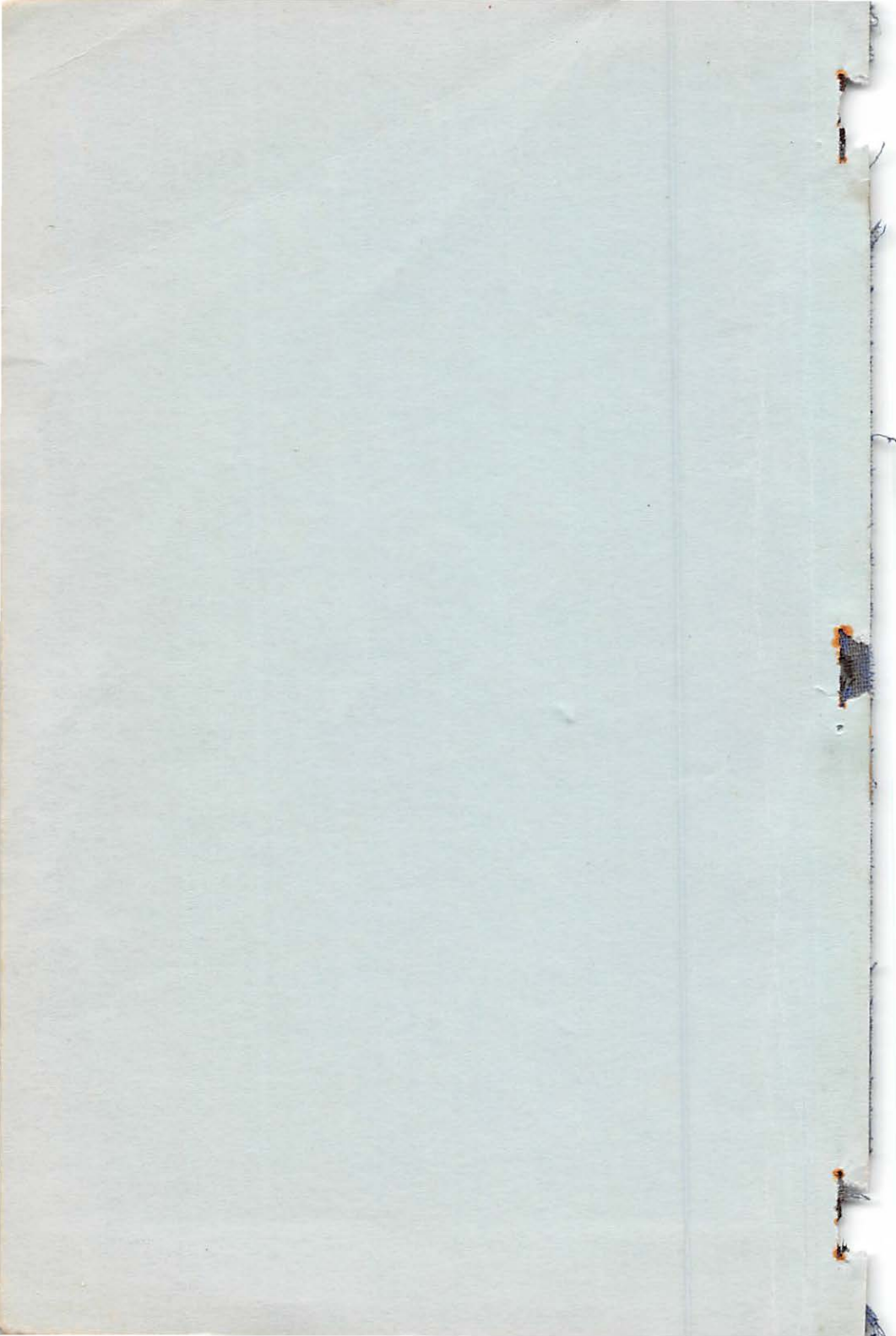
SEVENTH ANNUAL MEETING

Communication and Signal Section

CHICAGO, ILLINOIS

October 10, 11 and 12, 1967

Published by Communication and Signal Section, AAR
59 East Van Buren Street, Chicago, Illinois 60605



Association of American Railroads

OPERATIONS AND MAINTENANCE DEPARTMENT

OPERATING-TRANSPORTATION DIVISION

COMMUNICATION AND SIGNAL SECTION

August 1, 1967

To the Members:

The Advance Reports represents in condensed form a portion of the efforts of the members and officers of the various committees for 1967.

The 1967 Annual Meeting will provide an opportunity for the membership to participate in further discussion of these reports and other special papers that will be given at that time.

Each member is encouraged to study and review the reports carefully before the meeting and make any criticism or suggestion that may be constructive. Suggestions or comments should be forwarded as early as possible to the Chairman of the committee concerned, with a copy to the Secretary of the Section. It is important that this procedure be followed in order to conserve time at the Annual Meeting.

The reports included represent only a portion of the total work performed during the year, as many of the assignments are continuous. I am sure that the membership will join with the Committee of Direction in expressing our thanks to the many individuals who have contributed to the contents of these reports.

General distribution of the Advance Reports will not be made at the Annual Meeting; therefore, please bring your copy with you to the meeting.

V. S. Mitchell
Chairman

OPERATIONS AND MAINTENANCE DEPARTMENT

R. R. Manion, Vice President

OPERATING-TRANSPORTATION DIVISION

W. D. Lamprecht, Chairman

A. M. Harris, Vice Chairman

C. A. Lauby, Executive Vice Chairman

COMMUNICATION AND SIGNAL SECTION

Officers

Chairman

V. S. Mitchell, Signal Engineer, Chicago & North Western Ry., 400
W. Madison St., Chicago, Ill. 60606

First Vice Chairman

R. M. Laurenson, Superintendent Communications, St. Louis-San
Francisco Ry., 3253 E. Trafficway, Springfield, Mo. 65802

Second Vice Chairman

H. R. Beck, Assistant Chief Engineer - Administration, Canadian
National Rys., P. O. Box 8100, Montreal 3, Que.

Staff

I. H. Loucks, Engineer Communications and Signals

J. L. McNabb, Assistant Engineer Communications and Signals

George McCann, Secretary

W. E. Morrison, Assistant Secretary

COMMITTEE OF DIRECTION

MEMBERS

Term Expiring December 31, 1967

- East: J. G. Karlet, Manager Signals and Communications,
Norfolk & Western Ry.
- Canada: H. R. Beck, Assistant Chief Engineer - Administration,
Canadian National Rys.
- West: J. N. Albertson, General Superintendent Communica-
tions System, Southern Pacific Co.
- West: H. C. Macomber, General Superintendent Communica-
tions, Missouri Pacific R.R.

Term Expiring December 31, 1968

- East: T. L. Carlson, General Superintendent Signals and
Communications, Chesapeake & Ohio Ry. - Balti-
more & Ohio R.R.
- South: J. R. DePriest, Superintendent Communications and
Signals, Seaboard Coast Line R.R.
- West: T. W. Wigton, General Superintendent Communications,
Chicago, Burlington & Quincy R.R.
- West: Vacancy.

Term Expiring December 31, 1969

- Canada: A. S. Walker, General Inside Plant Engineer, Tele-
communications Dept., Canadian Pacific Ry.
- South: R. D. Liggett, Chief Engineer Communication and
Signaling, Seaboard Coast Line R.R.
- West: V. S. Mitchell, Signal Engineer, Chicago & North
Western Ry.

Term Expiring December 31, 1970

- East: K. M. Lockerby, System Engineer-Communications
and Signals, Pennsylvania R.R.
- South: G. Pipas, Director of Communications, Illinois Cen-
tral R.R.
- West: R. M. Laurenson, Superintendent Communications,
St. Louis-San Francisco Ry.

REPORT OF
COMMITTEE OF DIRECTION

August 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

Your Committee of Direction submits the following report:

Meetings

Since the 1966 Annual Meeting, the Committee has met on January 31 and February 1, 1967, and June 21 and 22, 1967. The Committee will also meet on October 9, 1967.

Rules of Order

The following changes in the Rules of Order have been approved by the Committee and the General Committee of the Operating-Transportation Division.

Article III--Organization - In paragraph 2, "on December 31," in the second line, has been changed to "with the close of the Annual Meeting."

Article V--Staff and Committees - Paragraph 2 (c) has been revised to read as follows:

(a) The standing committees of the Section will be as follows:

- Committee A--Outside Plant Facilities
- Committee B--Radio and Microwave Systems
- Committee C--Communications and Data Systems
- Committee D--Highway Grade Crossing Protection
- Committee E--Interlocking, Traffic Control and Block
Signaling Systems
- Committee F--Car and Engine Control Systems
- Committee G--Education and Training

Article VII--Duties of Staff - In paragraph 1 (a), the dates of November 1, in the first line, and November 10, in the fifth line, have been changed to the dates of August 1 and August 10, respectively.

Article VIII--Duties of Committees - In paragraph 1 (d), the date of October 1, in the first line, has been changed to the date of July 1. In paragraph 2 of the same Article, the date of November 1, in the second line, has been changed to the date of August 1.

Article XI--Letter Ballots - In paragraph 1, the words "and must be taken on all questions affecting physical property" have been deleted from the third and fourth lines.

Rules for Committees Committee

The following changes in the Rules for Committees Committee have been approved by the Committee.

Paragraph 2 (a) has been revised to read as follows:

(a) Standing committees shall be reappointed each year. The new roster and outline of work shall be distributed not later than July 1 and shall take effect at the close of the Annual Meeting.

Present paragraph 2 (b) has been deleted. Reletter present paragraphs 2 (c), (d), (e), (f) and (g).

Rules for Standing Committees

The following changes in the Rules for Standing Committees have been approved by the Committee.

Rule A-1 - The words "General Committee," in the last line, have been changed to "Committee of Direction."

Rule B-2 - The second, third and fourth sentences have been deleted. The first sentence remains as is:

Rule B-8 (d) - The first sentence has been revised to read: "(d) Names of railroads, manufacturers and trade names may appear in these reports; however, if they do not appear, the Secretary must be supplied with this information so it may be available upon request." No change was made in the last sentence.

Rule B-13 has been revised as follows:

B-13. Research projects recommended for handling by the AAR Research Center must be submitted to the Secretary for transmittal to the Director of Engineering Research, AAR.

Rule C-2 has been revised as follows:

C-2. All proposed additions and revisions to the Manuals must be printed in the Advance Reports for approval by the Member Roads.

Rule C-4 - The words "adopted by letter ballot," in the third line, have been changed to "approved."

Rule C-9 (c), (d) and (e) have been revised to read as follows:

- (c) Approval for inclusion in the Manual.
- (d) Approval to supersede subject matter in the Manual. (Designate subject matter to be superseded.)
- (e) Approval for elimination from the Manual.

Rule C-10 has been deleted.

Minor revisions have been made in Section D--Style Standards.

* * * * *

A revised Book of Rules of the Communication and Signal Section has been issued to all Senior Representatives, Designated Communication Representatives, Designated Signal Representatives, and standing committee members.

Committee on Nominations

In accordance with Article VIII, paragraph 1 (d) of the Rules of Order, the Committee has named the following Committee on Nominations.

- M. F. Black (Chairman), Supt. Comms., Denver & Rio Grande Western R.R.
- W. W. Hartzell, Engr. Sigs. & Comms., Boston & Maine Corp.
- K. L. Muse, Sig. & Comms. Engr., Western Maryland Ry.
- N. C. Pace, Asst. to Vice Pres. - Comms., Southern Ry. System.
- H. W. Trawick, Engr. of Sigs., Canadian Pacific Ry.

Committees Committee and Special Committees

Committees Committee

- R. M. Laurenson (Chairman), Supt. Comms., St. Louis-San Francisco Ry.
- J. N. Albertson, Gen. Supt. Comms. - Sys., Southern Pacific Co.
- H. R. Beck, Asst. Chf. Engr. - Admins., Canadian National Rys.
- J. R. DePriest, Supt. Comms. & Sigs., Seaboard Coast Line R.R.
- G. Pipas, Dir. of Comms., Illinois Central R.R.

Special Committee on Editing

- G. McCann (Chairman), Secretary, C&S Section, AAR.
- H. R. Beck, Asst. Chf. Engr. - Admins., Canadian National Rys.

Communication and Signal Section, AAR
Committee of Direction

E. A. Burgin, Supt. Sigs. & Comms., Chesapeake & Ohio Ry.
P. B. Burley, Asst. Dir. of Comms., Illinois Central R.R.
H. C. Macomber, Gen. Supt. Comms., Missouri Pacific R.R.
V. S. Mitchell, Sig. Engr., Chicago & North Western Ry.

Special Committee on Education and Training of Employees

A report of the Special Committee, which also shows list of personnel and assignments, appears as Exhibit A, page 13.

Special Committee on Railroad-Commercial Communications
Liaison

Railroad

P. A. Flanagan (Chairman), Supt. Comms. & Sigs., Chesapeake & Ohio Ry.
M. F. Black, Supt. Comms., Denver & Rio Grande Western R.R.
J. M. Hesser, Asst. Mgr. Sigs. & Comms., Norfolk & Western Ry.
R. C. Karvatt, Dir. of Comms. & Sigs., New York Central System.
J. H. Wallis, Asst. Gen. Supt. Sigs. & Comms., Chesapeake & Ohio-Baltimore & Ohio Rys.
C. H. Wesman, Asst. Gen. Supt. Sigs. & Comms., Great Northern Ry.

Commercial

R. J. Maher, Staff Rep. - Sales, American Telephone & Telegraph Co.
W. D. Orr, Customer Relations Mgr., Mgrmt. Info. Systems, The Western Union Telegraph Co.
D. J. Walrath, Planning Engr., Mgrmt. Info. Systems, The Western Union Telegraph Co.
T. R. Warner, Radio Engr., United States Independent Telephone Assn.

Special Committee on HVDC Transmission Coordination

- J. N. Albertson (Chairman), Gen. Supt. Comms. - Sys., Southern Pacific Co.
- A. J. Hendry, Sig. Engr., Northern Pacific Ry.
- C. O. Jett, Supt. Comms., Union Pacific R.R.
- H. C. Stratton, Gen. Sig. Engr., Union Pacific R.R.
- L. R. Thomas, Gen. Supt. Comms. & Sigs., Atchison, Topeka & Santa Fe Ry.
- H. C. Kendall, Mgr. - Advanced Engrg., General Railway Signal Co.
- C. E. Staples, Senior Con. Engr., Signal & Communications Division of Westinghouse Air Brake Co.

Special Committee on ICC Rules, Standards and Instructions

Members of this new Special Committee will be named at a later date.

Standing Committees

The personnel of standing committees and assignments thereto are listed herein preceding their reports.

The Committee appreciates the wholehearted efforts put forth by these committees during the past year and the further coordination and consolidation of activities. The Committee extends its thanks to the chairmen and members for their continued interest and contributions.

* * * * *

For the past 18 months, the Committee has been investigating the standing committee structure of the Section. It was the intention of the investigation to eliminate areas of duplicated effort and expand areas of interest which were not covered in the makeup of the ten committees.

The new alignment of committees, effective July 1, 1967, with purpose clauses added for explanation of the committees' duties is shown in Exhibit B, page 18.

Letter Ballot Approval

Items accepted at the 1966 Annual Meeting of the Section for submission to letter ballot for inclusion in the Communication Manual and the Signal Manual were submitted to the Senior Representatives

of the Member Roads on July 5, 1967 (Circular No. C&S-213), and approved. The results of the ballot were transmitted to the Senior Representatives on July 28, 1967 (Circular No. C&S-214). These items comprise the 1966 sets of Additions and Revisions of the respective Manuals.

Annual Meetings

The following special papers have been scheduled for the 1967 Annual Meeting:

- Communication Department's Role in a Management Information System, by Mr. R. P. de Camera, Vice President - Information & Control Systems, Illinois Central R.R.
- Zero Loss Dispatcher Circuit Combiner, by Mr. Eric Mitchell, Chief Engr. of Telephone Prods., Altec-Lansing Division of LTV Ling Altec, Inc.
- Dispatcher Controlled Radio System, by a representative of Louisville & Nashville R.R.
- Cable Systems--The Modern Communications Media for Railroads, by Mr. G. W. Carter, Comms. System Engr., Simplex Wire & Cable Co.
- BARTD Automatic Train Control, by Mr. W. P. Bollinger, Gen. Mgr., Westinghouse Electric Corp.
- Computer Operation of Bellevue, Ohio Retarder Yard, by Mr. J. M. Hesser, Asst. Mgr. Sigs. & Comms., Norfolk & Western Ry.
- Automatic Train Length Computer, by Mr. Arthur Glazar, Railroad Products Division, Servo Corp. of America
- Rapid Transit Signaling, by Messrs. C. L. Wiksten, Sig. Supt., Chicago Transit Authority, and L. M. Bellinger, Supt. Sigs., New York City Transit Authority
- Automatic Reservations System for Canadian National Railways Passenger Services, by Mr. J. E. Raymond, Asst. Chief of Sales & Traffic Services, Canadian National Rys.
- Building Blocks to Automatic Train Operation, by a representative of Signal & Communications Division of Westinghouse Air Brake Co.
- Effects of HVDC on Railroad Operations, by Mr. H. C. Kendall, Mgr. - Advanced Engrg., General Railway Signal Co.
- Report on ACI, by Mr. W. H. Thompson, Dir. of Data Control, Illinois Central R.R.

* * * * *

The future Annual Meetings of the Section have been scheduled as follows:

- 1968--Adolphus and Baker Hotels, Dallas, Texas--October 1, 2 and 3.
- 1969--Queen Elizabeth Hotel, Montreal, Quebec, Canada--September 16, 17 and 18.
- 1970--San Francisco Hilton, San Francisco, California--September 15, 16 and 17.

Sectional Meetings

East. The 1967 meeting was held in Washington, D. C., on May 11. Mr. N. C. Pace, Asst. to Vice Pres. - Comms., Southern Ry. System, presided as Chairman and Mr. J. G. Karlet, Mgr. Sigs. & Comms., Norfolk & Western Ry., was Committee of Direction Sponsor. There were 201 in attendance.

The 1968 meeting will be held in Cincinnati, Ohio. Mr. C. W. Donaldson, Comms. Supvr., Chesapeake & Ohio-Baltimore & Ohio Rys., will serve as Chairman and Mr. K. M. Lockerby, Sys. Engr., Comms. & Sigs., Pennsylvania R.R., will serve as Committee of Direction Sponsor.

West. The 1967 meeting was held in Kansas City, Missouri, on April 18. Mr. B. J. Hutton, Sig. Engr., Atchison, Topeka & Santa Fe Ry., presided as Chairman and Mr. T. W. Wigton, Gen. Supt. Comms., Chicago, Burlington & Quincy R.R., was Committee of Direction Sponsor. There were 175 in attendance.

The 1968 meeting will be held in St. Louis, Missouri. Mr. O. H. Summers, Gen. Supt. Comms. & Sigs., St. Louis-San Francisco Ry., will serve as Chairman and Mr. J. N. Albertson, Gen. Supt. Comms. - Sys., Southern Pacific Co., will serve as Committee of Direction Sponsor.

Affiliated Members

The total number of Affiliated Members is 465.

Railway Affiliated Members

The total number of Railway Affiliated Members is 246.

* * * * *

Many other items of policy and procedure also have been given consideration.

Respectfully submitted,

COMMITTEE OF DIRECTION

Exhibit A

REPORT OF SPECIAL COMMITTEE
ON EDUCATION AND TRAINING OF EMPLOYEES

- G. W. Vogen (Chairman), Asst. to Engr. of Sigs., Canadian National Rys.
G. A. Baldy, Asst. Supt. of Comms., Great Northern Ry.
W. H. Cumberland, Training Officer, Telecomms. Dept., Canadian National Rys.
M. L. Delaware, Supvr. Comms., Great Northern Ry.
E. L. Hite, Asst. Supt. Comms.-Traffic, Chicago, Rock Island & Pacific R.R.
T. J. Kremer, Supvr. Sigs., Illinois Central R.R.
D. W. Reece, Supvr. Comms., Denver & Rio Grande Western R.R.
F. W. Zabrockas, Supvr. Bridges & Bldgs., Chicago & Western Indiana R.R.

Consulting Member

- R. W. McKnight, Editor, Railway Signaling & Communications.

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. Preparation and revision of chapters on American Railway Signaling Principles and Practices, and lessons in the Communication Maintainers' Training Course.
2. Preparation of material and aids to educate communication and signal department employees.
3. Review Section 10--Education and Training, of the Communication Manual.

The committee submits for consideration, reports on the following subjects:

1. The committee has examined Chapter XII--Semaphore Signals, of the American Railway Signaling Principles and Practices, and as there is little or no demand for the material on this subject, this chapter was removed from the complete set.

As part of an overall program to upgrade and remove obsolete material from the American Railway Signaling Principles and Practices, the committee has undertaken the revision of Chapters VII--Non-Coded Direct Current Track Circuits, XI--Non-Coded Alternating Current Track Circuits, XXV--Coded Track Circuits, XXIII--Railroad-Highway Grade Crossing Protection, and IX--Rectifiers and Battery Chargers. The programmed learning method will be used in rewriting the material where applicable.

Action Recommended

Acceptance as information.

2. The committee has completed its survey of Member Roads (Circular No. C&S-169) which was conducted to ascertain training needs. Pertinent excerpts of this report are shown on page

Action Recommended

Acceptance as information.

2. The Visual-Aid Signal Training Program was discontinued in its present form on February 1, 1967. The material contained in the existing sets is being examined by the committee and will be incorporated into the AAR Signaling Principles and Practices.

Action Recommended

Acceptance as information.

3. The Special Committee is investigating the possibility of obtaining modern text books on specific subjects which would replace a number of the present Communication Maintainers' Course lessons, or which would augment certain of the existing lessons.

Action Recommended

Acceptance as information.

Respectfully submitted,

SPECIAL COMMITTEE ON
EDUCATION AND TRAINING
OF EMPLOYEES

REPORT ON RESULTS OF TRAINING ACTIVITIES QUESTIONNAIRE

Purpose of the Report.

The purpose of the report is to provide a summary of findings based on the training activities survey conducted by the Special Committee, and as reported by the Special Committee Chairman at the 1966 Annual Meeting, to submit recommendations for action as may be essential and beneficial to the Membership.

Summary of Findings.

1. Limited use is being made of educational facilities and materials presently available from sources such as equipment manufacturers.
2. Majority of the Communication Maintainers' Training Course is considered to be too elementary in nature, and consists of lesson material which is now out of date.
3. The American Railway Signaling Principles and Practices are considered useful for training and for reference purposes. A number of the texts require upgrading and revision, including deletion of obsolete material.
4. The Visual-Aid Signal Training Program is well prepared and contains useful material, but very few Member Roads actually use the material. Low sales volume on especially the last presentation had resulted in a financial loss to the Section.
5. Railroad members indicate the Special Committee can best serve Communication and Signal employees by providing up-to-date training and reference materials, and by providing information and guidance as to modern training methods and techniques.

Special Committee Recommendations.

After consideration of the above findings, the Special Committee submits the following recommendations:

1. Communication Maintainers' Training Course lessons, with the exception of Lessons B-2, B-4 and B-18, should be replaced with more modern materials. Certain specific items in the obsolete lessons should be included in revised Lessons B-2, B-4 or B-18 as pertinent.
2. The Special Committee should investigate the possibility of obtaining modern textbooks on specific subjects such as:
 - (a) Carrier Theory and Operation.
 - (b) Microwave Communication Systems.
 - (c) Installation and Maintenance of Mobile Two-Way Radio Systems.

Such texts should be screened by the committee members in conjunction with objective consultants or advisers to insure suitability of content and usefulness for instruction and reference material. Whenever possible, such material should be printed and distributed under the AAR cover.

3. The Special Committee should investigate the possibility and economics of having training material professionally prepared, and also the possibility of obtaining the rights to certain texts such as described in the Summary of Findings under Item 3 above, printed by a commercial publisher under the AAR cover, for sale to members at reduced cost as part of the Communication and Signal Training Programs. This would include more general subjects, such as electricity, electronics, solid state fundamentals, etc. In this manner, up-to-date material can be more easily obtained and maintained.

4. The American Railway Signaling Principles and Practices should be revised in a format which will provide an effective training course for Signalmen, and which will also be useful as a reference source. This can be done by utilizing a modified principle of programmed learning which provides a written text in conventional paragraph-chapter form, but which is suitably interspersed with questions, study assignments, etc.

Emphasis in design of the texts must be placed on provision for easy revision and/or replacement of pages or sections of the material.

5. The Special Committee recommends the Visual-Aid Signal Training Program be discontinued in its present form. The material contained in the existing sets should be incorporated into the American Railway Signaling Principles and Practices.

6. The Special Committee should compile for use by the Membership, a bibliography of recommended training courses and source material, including prices and availability. It would be a continuing function of the committee to maintain the list current and issue revised lists from time to time.

7. The Special Committee should continue to study and investigate new educational methods and techniques to insure that the members are supplied with latest developments as they occur for industrial training situations.

Plan of Action.

Upon acceptance of part of all of the recommendations contained herein, the Special Committee proposes the following steps to initiate action:

1. Efforts will be made to increase the Special Committee membership to create effective working groups under the direction of the subcommittee chairmen.

2. Present committee projects will be held in abeyance pending outcome of initial explorations leading to development of revised programs and subcommittee assignments.

3. The committee will contact the necessary outside agencies to determine the availability of commercial training material and texts.

4. An economic analysis will be conducted to determine feasibility of obtaining and using commercial material and/or professional assistance in preparing AAR courses and reference material.

5. The committee will immediately commence the necessary groundwork leading to establishment of a current bibliography of materials.

Acknowledgements.

The Special Committee members wish to express appreciation to the Member Roads and representatives who cooperated so excellently in providing information and data. The assistance of the Secretary and Mr. John L. McNabb, Assistant Engineer, Communications and Signals, is also greatly appreciated.

Exhibit B

A--OUTSIDE PLANT FACILITIES

This committee will be concerned with the outside communication plant and the wire and cable segments of signal systems. It shall prepare specifications, instructions, information and economic reports covering the hardware aspects of these facilities. It shall recommend standard construction practices including the construction of all radio towers, buildings and accessories.

B--RADIO AND MICROWAVE SYSTEMS

The primary functions of this committee will be liaison with regulatory bodies concerning assignment and use of radio frequencies and the rules under which such frequencies are used by railroads. It shall prepare standards and specifications for the installation, operation and maintenance of radio and microwave facilities and shall investigate the field of propagation and transmission of radio signals.

C--COMMUNICATIONS AND DATA SYSTEMS

The major responsibility of this committee will be to keep the Section informed of all new communication and data equipment and systems developments, such as type of system configurations and transmission characteristics. The activities of this committee will deal with all phases of inside communications plant except radio and microwave and shall include all forms of multiplexing equipment, telephone switching equipment, telephones and teleprinters.

D--HIGHWAY GRADE CROSSING PROTECTION

The primary aim of this committee is to seek and develop more effective methods and devices for protecting highway-railway grade crossings. It shall, by submission of timely reports, keep the Section informed of new methods and devices. It shall prepare and submit recommended circuit designs, requisites, specifications and plans to cover new developments and constantly review and revise existing requisites, specifications and plans to keep them current.

E--INTERLOCKING, TRAFFIC CONTROL AND BLOCK SIGNAL SYSTEMS

The major responsibility of this committee is to develop requirements for signaling systems and their components which will assist in moving trains between terminals more safely, faster and more economically. It shall, by the submission of timely reports, keep the Section informed of new developments which will accomplish this end. It shall prepare and submit recommended circuit designs, requisites, specifications and plans to cover new systems and devices and constantly review and revise existing requisites, specifications and plans to keep them current.

F--CAR AND ENGINE CONTROL SYSTEMS

This committee will study and make recommendations on methods for the remote control of engines; slave engine control systems; hot box, dragging equipment and broken flange detectors; automatic yards; computers; automatic car identification; and yard and terminal control systems.

G--EDUCATION AND TRAINING

The purpose of this committee is to prepare material for the education and training of railway communication and signal employees. Primary concern will be to prepare a series of programmed learning (self-teaching) courses covering the fundamentals of communication and signaling subjects. The committee will be alert to and knowledgeable of the latest developments in communications and signaling to enable it to update and issue new material and will inform the Section of the availability of educational materials and methods that may be appropriate for use in the industry.

REPORT OF
COMMITTEE 1--WIRE AND CABLE LINES

- K. M. Lockerby (Chairman), Sys. Engr. - Comms. & Sigs., Penn-
sylvania R.R.
C. H. Wesman (Vice Chairman), Asst. Gen. Supt. Sigs. & Comms.,
Great Northern Ry.
J. R. French, Supt. Comms., Missouri Pacific R.R.
G. H. Kuhn, Comms. Engr., Union Pacific R.R.
J. D. MacQuarrie, Gen. Outside Plant & Stds. Engr., Telecomms.
Dept., Canadian Pacific Ry.
W. L. Mansfield, Plant Engr. - Comms., Chicago & North West-
ern Ry.
R. W. Margsh, Engr. Sig. Matl. & Stds., Chesapeake & Ohio Ry.
J. C. Ramage, Engr. of Const. & Maint., Illinois Central R.R.
L. H. Simon, Const. Engr. Sys., Atchison, Topeka & Santa Fe Ry.
R. E. Stuckey, Gen. Supvr., Sigs. & Comms. Lines, Chicago,
Milwaukee, St. Paul & Pacific R.R.
B. C. Wattson, Gen. Outside Plant & Const. Engr., Telecomms.
Dept., Canadian National Rys.
H. Weatherly, Engr. Sigs., Long Island R.R.

Consulting Members

- D. L. Baxter, Exec. Engr., Reliable Electric Co.
L. B. Blum, Plant Sys. Engr., Plant & Engrg. Dept., The Western
Union Telegraph Co.
E. W. Glancey, Engr. Coordination & Protection, American Tele-
phone & Telegraph Co.

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments
any projects considered proper for submission to AAR Research
Center.
3. Cooperate with Sectional Committee of the United States of
America Standards Institute (formerly American Standards Associ-
ation) on Specification for Wood Poles, O5.
4. Investigate and report on various methods of treating poles
and timber used in communication and signal plant.

5. Report work being done by railroads and other bodies on the subject of protection against electrolysis and soil corrosion, collaborating with AREA Committee 18--Electricity.
7. Prepare specification for splicing plastic cables.
10. Investigate and report on use of new types of plastic wire insulation.
14. Prepare a specification for thermoplastic sheathed cable with polyethylene insulated conductors for direct burial in earth.
 - (a) For Signal use.
15. Collaborate with AREA Committee 1--Roadway and Ballast, in connection with its assignment 11--Chemical control of vegetation.
16. Keep in touch with the development of protective devices and report on items that the committee feels would be of particular interest to the membership.
18. Investigate and report on recent developments in mitigating effects of line hits by modifying protection or other means.
19. Investigate and report on aerial cable with built-in messenger support.
 - (a) For Communication use.
 - (b) For Signal use.
21. Investigate and report on the use of epoxy type resin in the damming of cables for pressurization, and if considered desirable, prepare specification or modification of existing specification for pressurization.
22. Investigate and report on availability of low loss paired wire in lieu of twisted pair.
23. Investigate and report on plastic lashing material for use as spinning wire.
25. Report on the advantages and disadvantages of all types of aluminum conductors as compared with copper for use on line circuits.
26. Prepare specification for line wire having copper covering welded to steel core (see Signal Manual Part 69).

The committee submits for consideration, reports on the following subjects:

1. Signal Manual Part 160--Specifications for Pin Type Insulators, revised as shown in Exhibit 1-A, page 24.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Manual Parts to be eliminated from the Communication Manual. The committee recommends the elimination of the following manual parts, as they are no longer current recommended practice.

- Manual Part 1-A-22--Typical Lineman's Tool House - Floor Plan.
- Manual Part 1-A-30--Specification for Typical Wood Booth for Roadway Telephone.
- Manual Part 1-A-35--Specification for Wood Pole Steps.
- Manual Part 1-A-42--Specification for Telephone Shelter Box - Type B.
- Manual Part 1-A-63--Specification for Metal Boxes AAR-3-A and AAR-4-A for Rubber Gloves.
- Manual Part 1-A-66--Specification for Dynamite Carrying Case AAR-1-A.
- Manual Part 1-E-4 --Instructions for Designating Dispatcher's and Message Telephone Circuits on Communication Pole Lines Along Railroads as a Means for Identification for Users of Portable Telephones.

Action Recommended

Approval for elimination from the Communication Manual.

1. **Manual Parts to be eliminated from the Signal Manual.** The committee recommends the elimination of the following manual parts, as they are no longer current recommended practice.

- Manual Part 20--Specification 145-52--Lead Sheathed Cable, Armored.
- Manual Part 26--Specification 90-59--Lead Sheathed Cable, Submarine.
- Manual Part 28--Specification 91-52--Lead Sheathed Cable, Non-Armored.

Action Recommended

Approval for elimination from the Signal Manual.

1. The following manual parts were approved by the committee for elimination from the Communication Manual, and reference placed in the Manual Index as to the Standards organization and number to which they presently refer.

- Manual Part 1-A-7 --Specification for the Butt Treatment of Cedar Poles (refer to AWWA C-7 in index).
- Manual Part 1-A-10--Specification for Creosoting Timber Other Than Poles Used in the Telegraph and Telephone Plant (refer to AWWA C-1 and C-2 in index).
- Manual Part 1-A-16--Specification for Galvanized Copper Bearing Steel Tie Wires (refer to ASTM A112 in index).

- Manual Part 1-A-17--Specification for Galvanized Steel Strand (refer to ASTM A475 in index).
- Manual Part 1-A-25--Specification for the Pressure Treatment of Southern Pine Poles (refer to AWPAC-1 and C-4 in index).
- Manual Part 1-A-40--Specification Covering the Method of Testing Tin Coating on Copper Wire (refer to ASTM B33 and B246 in index).
- Manual Part 1-A-53--Specification for Galvanized Copper Bearing Steel Line Wire (refer to ASTM A111 in index).
- Manual Part 1-C-3 --Specification for Creosoting Timber (refer to AWPAC-1 in index).
- Manual Part 1-C-4 --Specification for Fiber Conduit (refer to Govt. Printing Office in index).
- Manual Part 1-D-5 --General Specification for Galvanizing for Iron and Steel (refer to ASTM A90, A153, A239 and B6).

Action Recommended

Approval for elimination from the Communication Manual.

16. Gas-Filled Protectors for the Protection of Communication Plant, as Exhibit 1-B, page 25.

Action Recommended

Acceptance as information.

21. Instructions for Installation of Epoxy Resin Type Pressure Dams in Communication Cables, as Exhibit 1-C, page 26.

Action Recommended

Approval for inclusion in the Communication Manual.

Respectfully submitted,

COMMITTEE 1--WIRE AND
CABLE LINES

Exhibit 1-A

(Revised Signal Manual Part 160)

SPECIFICATIONS FOR PIN TYPE INSULATORS

1967

1. The recommended specification for wet process porcelain insulators for low and medium-voltage pin type is current USA Standard C29.5, issued by the United States of America Standards Institute. In size and shape, the insulators shall conform to the following AAR Signal drawings:

(a) Drawings 1282 and 1283, for voltage ranges up to 5 kv.

(b) Drawing 1284, for voltage ranges up to 660 v.

2. The recommended specification for wet process porcelain insulators, high-voltage pin type, is current USA Standard C29.6, issued by the United States of America Standards Institute, suitable for voltages 5 kv to 13.2 kv.

3. The recommended specification for communication and signal pin type line glass insulators is ASTM current Specification D 879, issued by the American Society for Testing and Materials, suitable for voltages up to 660 v. Pin type glass insulators in accordance with AAR Communication Manual Part 1-A-33 are included in ASTM current Specification D 879.

Note. --Insulators are classified by typical application voltages. These voltages are not to be interpreted as restrictive, or as a specific voltage rating assigned to the insulator. Successful operation of an insulator is influenced by its exposure to atmospheric conditions or contamination. Where exposure is mild, the use of an underrated insulator is feasible. Severe conditions and contamination may necessitate the use of an insulator larger than shown in paragraphs 1 and 2. It is often the case that severe conditions or contamination are encountered on only limited sections of a line. In such cases, oversize insulators are required only in the affected areas.

Exhibit 1-B

GAS-FILLED PROTECTORS FOR THE PROTECTION
OF COMMUNICATION PLANT

A report on page 51 of the 1964 Advance Reports described a specific type of gas-filled protector and outlined the manner in which a Canadian Railroad proposed to subject it to field trials. A further report was provided on page 83 of the 1966 Advance Reports giving the results of the trials.

A recent check with the major communication companies in Canada, including the two major railroads, indicates that without exception all are using gas-filled protectors to a greater or lesser extent. The type reported on in the 1964 Advance Reports appears to enjoy greater usage than any of the several types now available, but all types in use appear to be providing excellent protection.

Notwithstanding the above, there seems to be an obvious reluctance on the part of the companies using these protectors to standardize on them or on any particular type. It is probable that this reluctance stems from a variety of deficiencies which have not yet been fully overcome. The report appearing in the 1966 Advance Reports referred to the rusting of the exposed metal parts of the tube in the type described. This difficulty still exists, although in fairness it should be stated that no evidence has become available that this has in any way interfered with the ability of the protector to provide efficient electrical protection. In another type, using a glass tube, careful handling is required and the glass is also apt to shatter under heavy discharge. One type shows considerable variation in discharge voltage between day and night.

The improvements in continuity of service and the savings in maintenance costs resulting from use of these protectors are too striking to be overlooked. It is considered that most of the companies concerned have come to the conclusion that their use is justified at least in those areas where continuity of service is of prime importance or where the cost of replacement of the older types of protectors is unduly high, even though improvements in design may render presently available types obsolete.

Exhibit 1-C

INSTRUCTIONS FOR INSTALLATION OF EPOXY RESIN TYPE
PRESSURE DAMS IN COMMUNICATION CABLES

A--Scope

A-1. These instructions describe the method of installing epoxy resin pressure dams in communication cables (except those containing video or shielded pairs). This is an alternative method to that described in Manual Part 1-A-11, sections E to G, inclusive, which covers the installation of cold resin pressure dams.

B--Special Tools and Material Required

B-1. Tools. Tools required, in addition to a cable splicer's standard kit, are listed below. (The list is a complete list and not all of these tools are required to make any one type of dam.)

- (a) Gun, Injection.
- (b) Drill, Cable, 1/4 in.
- (c) Drill, Cable, 3/8 in.
- (d) Grip, Flange, C.
- (e) Reducer, Nipple 1/4 in. to 1/8 in. Male Pipe Thread.
- (f) Pliers, Constriction.
- (g) Depressor, "B" Cable Core.
- (h) Constrictor, Cable Sheath.
- (i) Apron, Compound Cartridge Warming.

B-2. Material. The material listed below is a complete list for all types of splices. (Not all of this material will be required for any one type of dam.)

- (a) Compound No. 163--6 oz. Cartridge.
- (b) Compound No. 163--2 oz. Cartridge.
- (c) Fitting, Sheath, USF-1.
- (d) Tape, Electric, 3/4 in.
- (e) Tape, Electric, 1-1/2 in.
- (f) Clamps, Hose (Various Sizes).
- (g) Paster, Gummed Paper, 2 in.
- (h) Pins, Plastic Channeling P-9.
- (i) Washer, Rubber "O" Ring, 316.

B-3. For further information concerning tools and materials listed in paragraphs B-1 and B-2, refer to Appendices A and B.

C--General

C-1. These instructions describe a satisfactory method for the installation of pressure dams in lead, alpth or stalpth sheathed, paper, plastic or textile-insulated cables using Epoxy Resin No. 163 compound and the direct sheath injection method. Materials, tools

and methods other than those described herein also may prove to be suitable for the installation of epoxy resin dams.

C-2. Since the installation of a dam involves several steps, some of which must be completed within a limited time, the user should study and be familiar with these instructions before attempting to start work on installing a dam.

C-3. Epoxy Resin No. 163 compound may be installed in an environmental temperature between 4 C (40 F) and 43 C (110 F).

C-4. Since the shelf life of Epoxy Resin No. 163 compound is only one year, care must be exerted that it is not ordered into the field before it is actually required. The older cartridges on hand should always be used first.

C-5. Requirements for Pressure Dams. Epoxy resin pressure dams will be required at the following points:

- (a) Ends of cables except where gas-tight terminals are employed.
- (b) At intermediate points where continuity of sheath is interrupted.
- (c) At the junction of plastic-insulated and paper-insulated conductors.

C-6. The amount of compound required to properly dam a cable depends on the size and type of the cable involved. Table 1 is intended to serve only as a general guide.

Table 1

CABLE DIAMETER, inches	Ounces of Compound (approximately)				Minutes of Injection (approximately)			
	LCPI	STALPETH	ALPETH	TEXTILE	LCPI	STALPETH	ALPETH	TEXTILE
1/2	3/4	-	1	-	10	-	10	-
1	2	-	3	-	10	-	12	-
1-1/4	6	12	8	7	15	25	20	15
1-1/2	18	24	20	10	30	40	30	35
1-3/4	24	28	26	12	50	60	50	40
2	28	30	28	12	60	65	60	40
2-1/4	30	36	30	-	60	75	60	-
2-1/2	36	42	-	-	70	80	-	-
2-3/4	36	42	-	-	75	85	-	-

D--Preparation of Compound

D-1. Procedures for Temperatures Between 18 C (65 F) and 43 C (110 F). Remove constricting band from around the cartridge (Fig. 1).

D-2. Pull dasher rod out until dasher is against the top of the cartridge (Fig. 2).

D-3. Compress the aluminum foil barrier which separates the compounds to allow them to flow together for proper mixing (Fig. 3).

D-4. Mix the compounds thoroughly in the cartridge by pushing the dasher rod completely in and out 60 to 70 times. (CAUTION: Complete mixing is essential!) During the mixing operation, keep rotating the dasher rod in a clockwise direction to prevent the dasher rod from being unscrewed from the dasher. After the mixing cycle is completed, pull the dasher rod to its furthestmost "out" position.

D-5. Remove the red seal cap from the bottom of the cartridge (Fig. 4). (CAUTION: Do not exert pressure on the cartridge when removing the seal cap, as this may damage or distort the plunger under the seal cap and allow the compound to flow past the plunger when pressure is applied with the injection gun.)

D-6. Firmly grasp cartridge to hold the dasher (Fig. 5). Loosen the dasher rod from the dasher but do not unscrew completely. The dasher rod must not be removed from the cartridge until the cartridge has been placed in the injection gun. (CAUTION: The time from the beginning of mixing the compound in the cartridge to the start of injecting it into the cable must not exceed 5 minutes.)

D-7. Procedures for Temperatures Between 4 C (40 F) and 18 C (65 F). Lower working temperatures (environmental) ranging from 18 C (65 F) to 4 C (40 F) cause the compound to gradually become thicker in the cartridge. To assure proper flow and penetration of the compound when injected into a cable, it must be warmed slightly, to place it in the same natural liquid state as for working temperatures above 18 C (65 F). (CAUTION: Do not attempt to use the compound for constructing a cable dam when environmental temperatures are below 4 C (40 F); use a manhole heater, or cable tent and heater to provide a higher environmental temperature.)

D-8. The compound cartridge warming apron, Fig. 6, will be required. The apron shall be worn underneath the workman's jacket. The heat generated from the workman's body provides warmth to the cartridge.

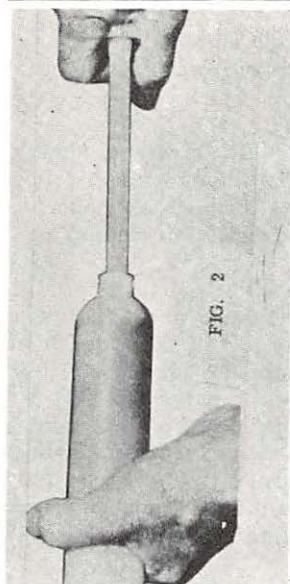


FIG. 2

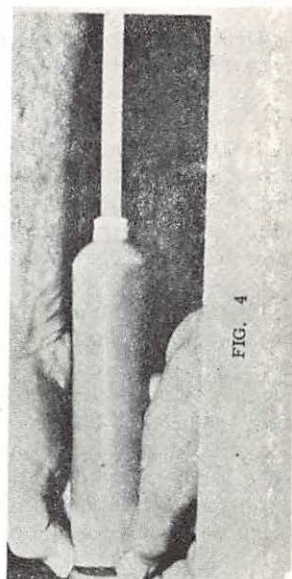


FIG. 4

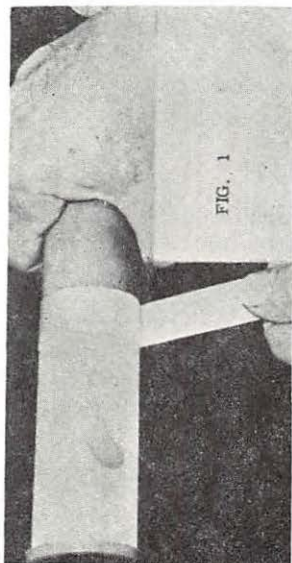


FIG. 1



FIG. 3

D-9. Upon arrival at the job site, place the number of cartridges to be used at the work location in the apron, underneath the workman's jacket.

D-10. Immediately prior to preparing a cable for direct sheath compound injection, remove one cartridge from the apron and follow the procedure described in paragraphs D-1 through D-4, except apply only 50 strokes with the dasher. Upon completion of this, return the cartridge to the warming apron.

D-11. Immediately upon completion of the cable preparations for compound injection, remove the previously mixed cartridge from the apron and further mix the compound 25 more full strokes. Then remove cap and loosen dasher rod as described in paragraphs D-5 and D-6. (CAUTION: The time from the first mixing of the compound up to and including the second mix must not exceed 15 minutes. (The longer working time than stated in paragraph D-6 is permitted due to colder temperatures.) It is imperative that all cable preparations be planned so as not to exceed the injection time limits.)

D-12. If more than one cartridge is required for one specific cable dam, proceed as follows:

(a) As soon as the injection of the first cartridge is started, remove a second cartridge from the warming apron, mix 50 full strokes and return it to the apron.

(b) When the first cartridge is completely injected, remove the second cartridge from the apron and mix 25 more strokes.

(c) Remove the first cartridge from the cable and start injection of the second cartridge.

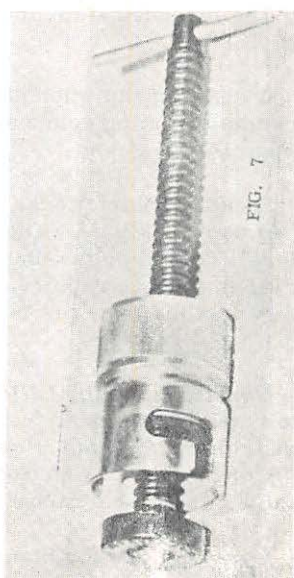
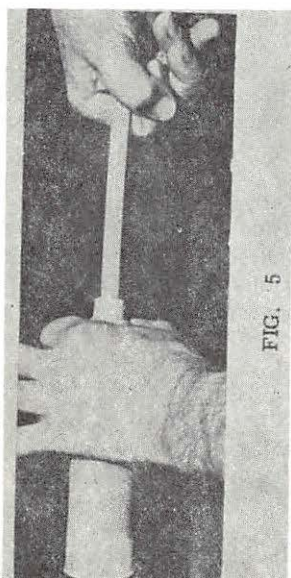
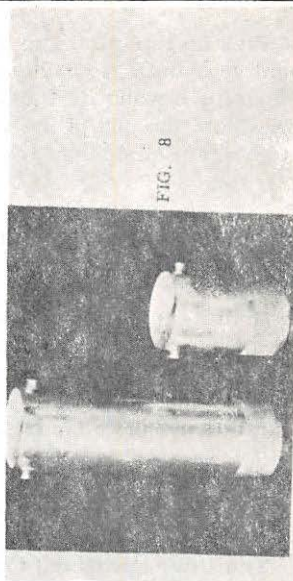
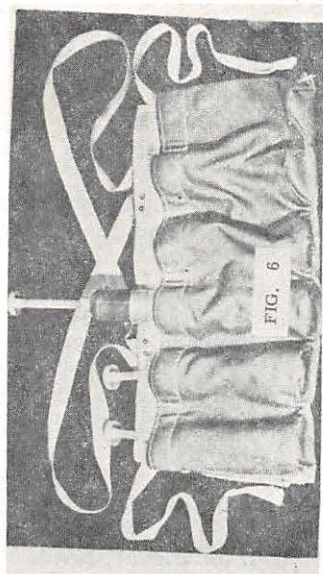
(d) Repeat the above procedures for the number of cartridges required to complete the dam.

E--Preparation of Injection Gun

E-1. Injection Gun. The compression type injection gun, Fig. 7, is used to inject compound from either a 2-oz. or a 6-oz. cartridge.

E-2. Cartridge Retainer. A steel cylindrical retainer, Fig. 8, is required to lock the cartridge to the injection gun. It also prevents the wall of the cartridge from expanding during compound injection. There are two sizes of retainers, one for the 2-oz. cartridge and one for the 6-oz. cartridge.

E-3. Assembling Cartridge with Injection Gun. Select the correct size cartridge retainer, pass it, locking end first, over the dasher rod end of a thoroughly mixed (paragraphs D-1 or D-2) cartridge (Fig. 9) until it rests against the flange; insure that the dasher rod is in full out position, but do not remove it from the cartridge.



E-4. Pick up injection gun by the handle and spin the housing on the worm gear until it reaches the disc. (CAUTION: Do not force the housing beyond its furthestmost down position, as this may pop the disc from the end of the worm gear stem and cause the ball bearings to become dislodged from the worm gear housing.)

E-5. Lock the cartridge retainer to the injection gun by inserting the two buttons in the open slots of the gun and turning into locked position (Fig. 10).

E-6. Holding injection gun with the dasher rod point upward, remove the dasher rod by unscrewing it from the dasher (Fig. 11).

E-7. After the dasher rod is removed, Fig. 12, the cartridge can be screwed onto the appropriate cable fitting for compound injection.

F--Sheath Fitting and Sheath Constrictions

F-1. The USF-1 Fitting, Fig. 13, is used for direct sheath compound injections into LCPI, alpeth, stalpeth, and textile-insulated types of cable 1 in. and over in diameter.

F-2. An adhesive gasket is preaffixed to the base of the fitting with a tear-off sheet added to the adhesive to protect it until the fitting is required for use (Fig. 14).

F-3. The threaded stem accepts the injection end of the cartridge (Fig. 15).

F-4. A snap-on cap when placed on the threaded stem of the fitting prevents damming compound from escaping through the stem opening (Fig. 16).

F-5. Sheath Constrictions. Cable sheath constrictions are required at all dam locations. The depth of the constrictions in the cable sheath will depend on the diameter of the cable. Usually cables 1 to 1-1/2 in. and larger require constrictions approximately 1/4 in. deep; cables smaller than this require constrictions approximately 1/8 in. deep.

F-6. Constrictions for LCPI Cable. For LCPI cable 1 inch in diameter or larger, constrictions shall be made using the cable sheath constrictor 6 in. apart and as uniformly around the cable as possible. Completed constrictions are shown in Fig. 17. (For smaller cables, see paragraph F-17.)

F-7. Constrictions for Stalpeth Cable. This cable, unlike lead sheath cable, has a polyethylene outer jacket with an inner steel and aluminum terneplate barrier next to the paper cable conductor core-

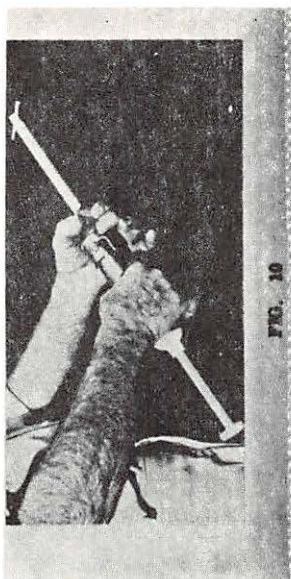


FIG. 10

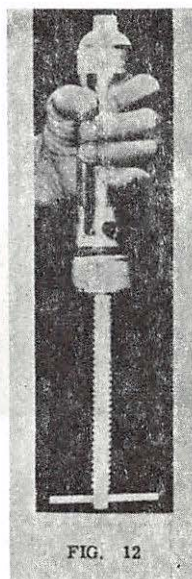


FIG. 12

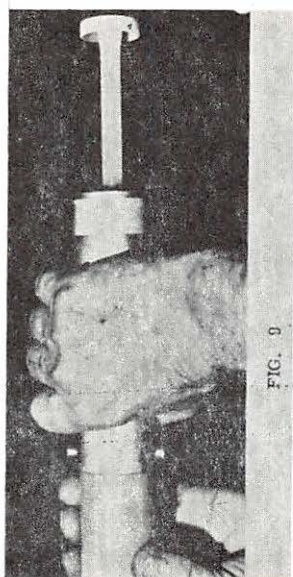
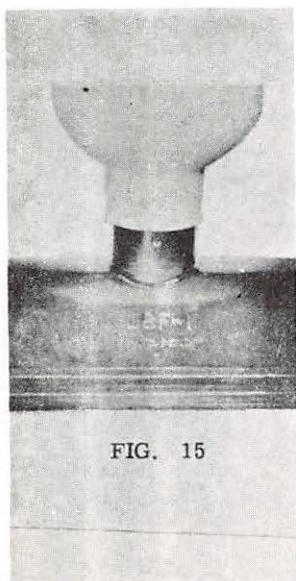
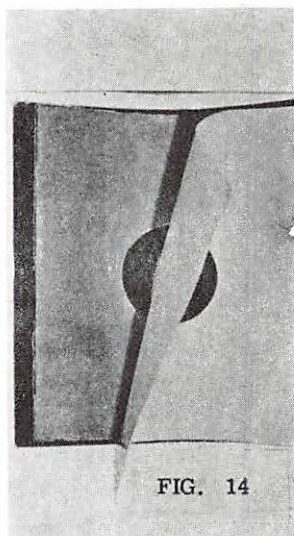


FIG. 9



FIG. 11



wrapper. To constrict this cable for damming purposes, it is necessary to remove portions of the polyethylene jacket to explore the inner steel terneplate. The following outlines the procedures to create constrictions in stalpeth cables, 1 inch in diameter or larger. (For smaller cables, see paragraph F-17.)

F-8. The sheath constrictions shall be made 7 in. apart. First, measure and mark off 8 in. on the sheath. Next, place marks on the sheath 1-1/4 in. inward from each of the 8-in. marks (Fig. 18).

F-9. Completely strip both 1-1/4 in. sections of sheath from the cable. Do not nick or score the steel terneplate when cutting or removing this outer sheath.

Figure 19 shows the stalpeth cable with the sheath removed and ready for the required constrictions.

F-10. Using the cable sheath constrictor, form an indentation ring around the exposed terneplate midway in each 1-1/4 in. opening in the sheath. Care must be exercised, as the metal terneplate will buckle and crack if the constrictions are not worked in very gradually. Proceed until a 1/4 in. deep depression is made.

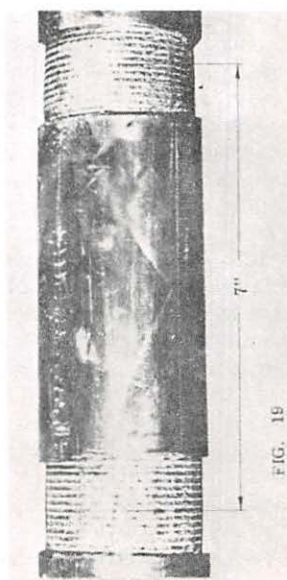
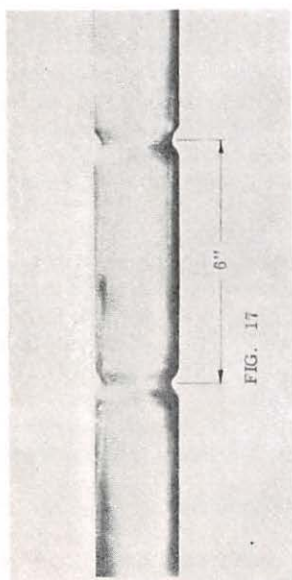
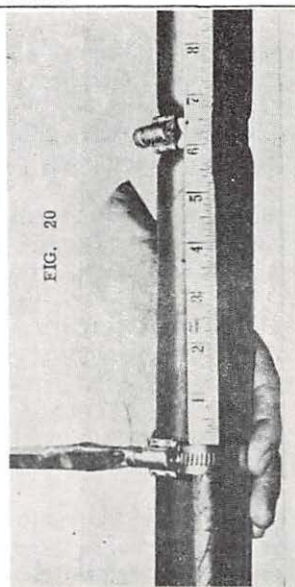
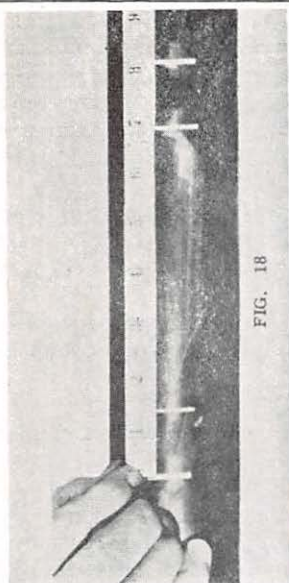
F-11. Constrictions for Alpeth Cable. This cable is similar in appearance to stalpeth cable but differs in the internal makeup. Underneath the polyethylene jacket is an aluminum shield. Between this shield and the conductors, which are polyethylene-insulated, is a vinyl core-wrapper. The soft aluminum shield cannot be constricted by using the procedures outlined for stalpeth cable. Due to the internal structure of alpeth cable, there is less resistance to compression, and therefore, pressure applied to the external polyethylene jacket will collapse the sheath sufficiently to constrict the inner aluminum shield and conductors enough to prevent a free flow of compound. The following outlines the procedures to create constrictions in alpeth cables of any size.

F-12. The sheath constrictions shall be made with two hose clamps (worm gear type) placed around the cable, spaced 6 in. apart. Protect the cable sheath beneath the hose clamps with four layers of 3/4 in. plastic tape. These hose clamps will remain in place after the compound has been injected.

F-13. With a large screwdriver (Fig. 20), tighten the hose clamps as much as possible to create the required depressions.

Figure 21 shows the completed constrictions.

F-14. Constrictions for Textile-Insulated Cable. In external appearance, this cable is the same as LCPI cable. However, the sheath is much softer and the conductors are insulated with either



acetate or silk and cotton threads. It is primarily used as a terminating cable for office distribution frames. Unlike the paper, pulp or polyethylene insulation in other cables, the textile-insulated cable insulation will not readily accept the compound that is injected for damming purposes. For the compound to properly penetrate the insulation, more resistance (constriction) to the flow of compound through the cable is required than is normally necessary to dam other types of cables. Therefore, four constrictions in this cable sheath are required to produce the necessary back pressure. The following outlines the procedures to create constrictions in textile-insulated cables, 1 inch in diameter or larger. (For smaller cables, see paragraph F-17.)

(a) Place two marks on the cable sheath 10 in. apart. Within these marks and 2 in. from them place two more marks on the sheath. The cable constrictions will be made at these four marks.

(b) Make the two inside constrictions first (Fig. 22). The constrictions must be worked in very gradually by rotating the cable sheath constrictor around the cable.

F-15. Constrictions for Terminal Stubs and Small Cables. The cable sheath constrictor cannot be used successfully on stubs or cables less than 1 inch in diameter; therefore, stubs and small cables shall be constricted using constriction pliers as described in this subsection, with the following exceptions:

(a) Constrictions on alpth or plastic stubs shall be made with hose clamps as described in paragraph F-11.

(b) Constrictions for LCPI, stalpth or textile-insulated stubs 1 in. or larger in diameter shall be made as described in paragraphs F-6, F-7 and F-14.

F-16. Constrictions for LCPI, stalpth or textile-insulated stubs or cables less than 1 inch in diameter shall be made as described above, except constriction pliers (Fig. 23) shall be used instead of the cable sheath constrictor. These pliers are so designed that they may be used to constrict cables up to 7/8 inch in diameter.

F-17. The constriction should be worked in gradually by alternately applying pressure and releasing the pliers as they are moved around the cable (Fig. 24). The pliers should not be rotated while pressure is being applied, as this removes some of the lead sheath and weakens the cable structure at this point. Form the constriction to a depth of 1/8 in.

G--Location of Dams

G-1. General. Dams may be made in either a vertical or horizontal section of cable. They should not be located within 30 in. of the location where a splice, pressure valve or pressure connection is likely to be required in the future. The center of a dam should not be located closer than 24 in. from the nearest end of an existing

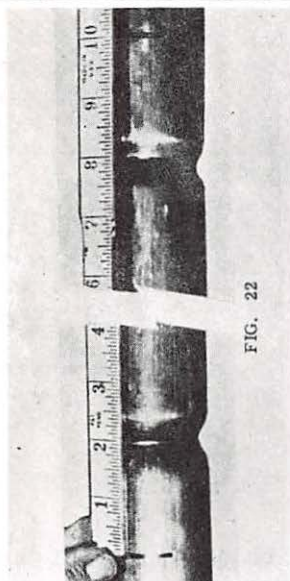


FIG. 22

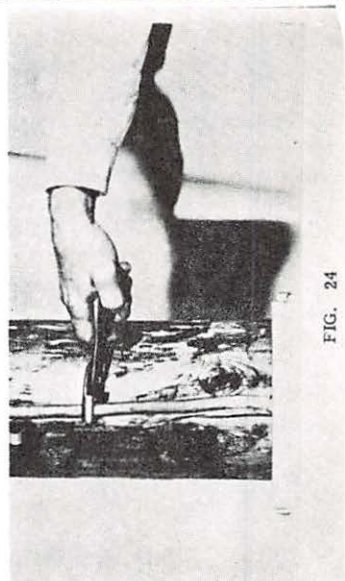


FIG. 24

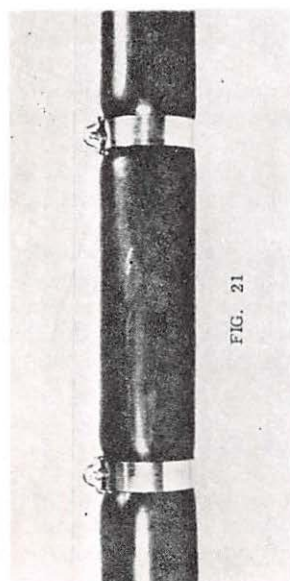


FIG. 21

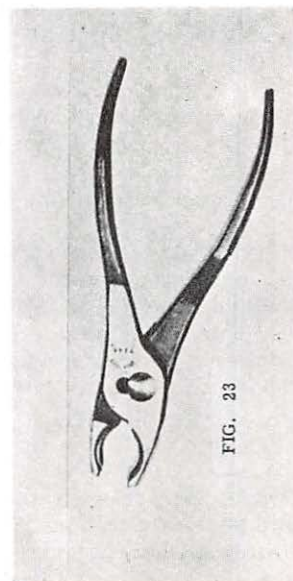


FIG. 23

splice, pressure valve or pressure connection.

G-2. **Terminal Stubs.** For non-gas type terminals, a sheath constriction should be made in the terminal stub 8 in. away from the terminal housing. The compound should be injected midway between the terminal housing and the constriction (Figs. 25 and 26).

G-3. For unsealed terminals, two constrictions are required in the stub to keep the compound from escaping. Make one constriction 4 in. from the terminal housing and the second 10 in. from the housing. The compound should be injected midway between these two constrictions.

G-4. **Riser Cables.** In riser cables, the dam should be located approximately 12 ft. above the ground level, to afford easy access to pressure testing valves and bypasses.

G-5. **Manholes and Cable Vaults.** Careful planning must be exercised in locating dams in manholes or vaults; at least 4 and preferably 5 ft. of cable must be available between the splice and the duct entrance to accommodate a dam with a bypass. (See other distance limitations in paragraph G-1.)

G-6. In cable vaults, dams should be placed in convenient locations to conform to cable racking and to facilitate required tubing runs from the compressor dehydrator used to pressurize the cable.

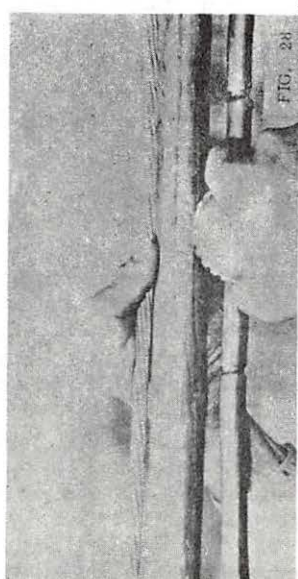
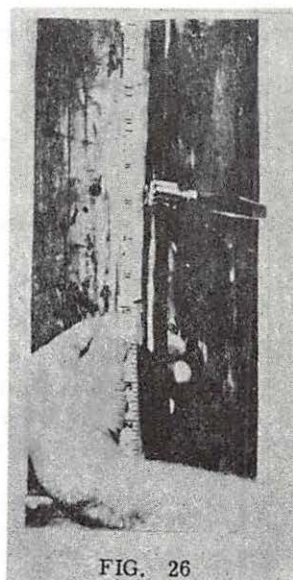
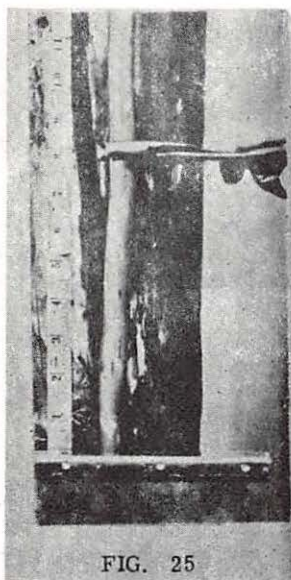
H--Dams In Small Cables and Terminal Stubs

H-1. **General.** The damming of terminal stubs and cables less than 1 inch in diameter consists of preparing the cable, forming the sheath constrictions and injecting Epoxy Resin No. 163 compound into the cable core.

H-2. **Preparing Cable.** Any air pressure in the cable must be released from the section where dam is to be installed before injection of any compound. This is required so that voids will not form in the injected compound. Pressure must not be reapplied until the compound has hardened. When several terminals on the same cable are to be dammed, the opening of a valve at the nearest branch splice, in the direction towards the pressure source, will generally allow the pressure to be dissipated.

H-3. When the dam is to be made in a vertical section of a terminal stub or cable, remove any cable straps and reform the cable 3 in. away from the pole or wall, so that the constriction may be formed easily.

H-4. When the dam is to be made in a horizontal section of a terminal stub or cable, remove the cable supports on either side of



the dam location to allow sufficient working space to form the sheath constrictions. The cable should be handled very carefully to prevent any damage to its sheath.

H-5. **Sheath Constrictions.** Make sheath constrictions as outlined in paragraph F-5.

H-6. **Drilling Sheath Holes in Lead-Sheathed Cable.** When drilling holes in lead sheathed cables, avoid any damage to conductor insulation. Drill only to the paper core-wrapper. Use a 1/4 in. cable drill and make a hole in the sheath midway between the constriction and the terminal housing (paragraph G-2; see Fig. 27) or midway between the two constrictions (paragraph G-3; see Fig. 28).

H-7. Remove any surface burrs caused by drilling the hole, but do not deform the hole in any manner, as this will cause improper sealing of the "C" Flange Grip (Fig. 31) which would allow compound to escape during injection.

H-8. Remove the cable core wrapping paper. This can best be done by making a series of closely-spaced holes in the paper around the opening with an orange stick. Then pick out the paper disc (Fig. 37).

H-9. **Drilling Sheath Holes in Alpeth Cable.** Using the same techniques as specified for lead sheathed cable, drill a 1/4 in. hole through the outer plastic sheath but do not penetrate the inner metal barrier (Figs. 29 and 30).

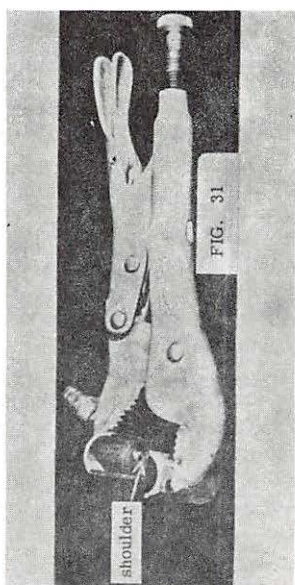
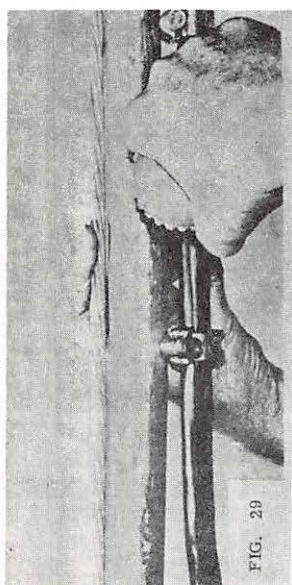
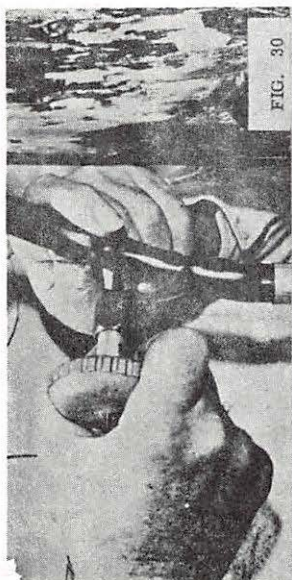
H-10. Remove the metal barrier and vinyl core-wrapper with an orange stick and long nose pliers. Use extreme care in removing the vinyl cable core-wrapper, so as to avoid damage to conductor insulation.

H-11. **"C" Flange Grip.** The "C" flange grip is a special tool which facilitates injecting compound into terminal stubs and cables less than 1 inch in diameter. A vise-like tool, Fig. 31, has a semi-circular plate attached to jaws that will compress around the cable. It remains in place when properly adjusted (with the end screw stem) for the cable diameter size. The following is a more detailed description of the tool and its proper use:

(a) Extending through the inside of the oval plate is a 1/8 in. shoulder that fits into the hole drilled in the cable sheath.

(b) A rubber washer ("O" ring) fits on the shoulder to seal around the outside of the hole when the tool is compressed around the cable. This shoulder must be seated carefully in the drilled hole so that proper fit of the "O" ring will eliminate any compound leakage.

(c) The threaded barrel on the outside jaws of the tool will accommodate a 1/4 to 1/8 in. reducer nipple which enables the com-



pound cartridge and the pressure gun to be attached to the "grip." (In Fig. 31, the reducer nipple is shown attached to the "C" flange grip.)

H-12. Injecting Epoxy Resin No. 163 Compound. Place the "C" flange grip with reducer nipple on the cable that has been prepared for compound injection (Fig. 32).

H-13. Use a 2-oz. compound cartridge for cables less than 1 inch in diameter.

H-14. Mix the compound thoroughly as described in paragraph D-1 or D-7, whichever is applicable. Assemble the cartridge with the injection gun, as described in paragraph E-3. Attach the cartridge to the reducer nipple on the "C" flange grip (Fig. 33).

H-15. Inject the compound into the cable by turning the injection gun handle a quarter turn at a time in a clockwise direction. When back pressure can be felt through the tool, allow several seconds for the compound to settle before again turning the handle.

H-16. Due to the relatively small void in the constricted area of terminal stubs and small cables, very little compound is required to dam these cables. Usually about 3/4 to 1 oz. is sufficient. The injection of the correct amount can be regulated by turning the handle of the gun no more than three to four complete turns after back pressure is felt through the gun.

H-17. All injections should be made very slowly to allow the compound to penetrate the insulation properly (in the case of paper, pulp or textile-insulated conductors) and to fill all voids between the cable sheath and conductors. The injection of compound should take no less than 10 minutes and preferably 15 minutes (especially when plastic-insulated conductors are involved).

H-18. Upon completion of compound injection, maintain the gun pressure for at least 1 minute to enable back pressure to dissipate.

H-19. Release gun pressure by turning handle several times in a counterclockwise direction.

H-20. Remove cartridge and gun from the reducer nipple and discard the used cartridge.

H-21. Remove the "C" flange grip from the cable and cover the injection hole with three wraps of 3/4 in. plastic tape (Fig. 34).



FIG. 34

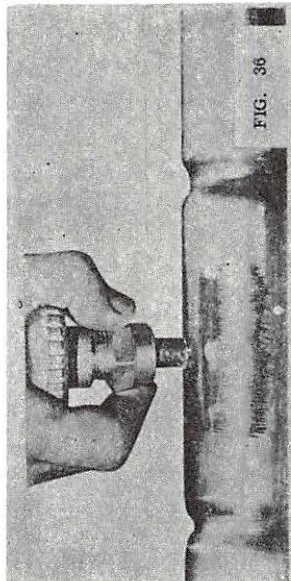


FIG. 36



FIG. 33

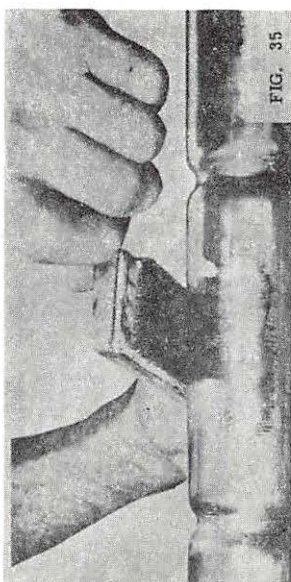


FIG. 35

I-1. Make two sheath constrictions 6 in. apart using the constriction tool, in accordance with paragraphs F-5 and F-6.

I-2. With a file card, clean an area midway between the constrictions, (Fig. 35). This should be large enough to accept the full base of the USF-1 sheath fitting.

I-3. In the center of the cleaned area and using a 3/8 in. cable drill, make a hole in the lead sheath (Fig. 36). Avoid any damage to the conductor insulation. Drill only to the paper core-wrapper, not through it.

I-4. Remove the paper core-wrapper by making a series of perforations in the paper around the drilled sheath opening with an orange stick. Then pick out the paper disc (Fig. 37).

I-5. Through the hole made in the lead sheath, completely insert two full-length plastic channeling pins at a 45 deg. angle and longitudinally to the cable length, one in each direction (Fig. 38). (On cables of diameters from 1 to 1-1/2 in., cut channeling pins in half before inserting them.) The presence of the pins provides a void through the conductors of the cable for easy access of the compound to enable it to saturate properly all the conductors.

I-6. Remove the protective covering from the adhesive gasket backing of a USF-1 sheath fitting (Fig. 39). Center the fitting hole directly over the drilled hole in the cable sheath and apply pressure firmly to all sides of the fitting (Fig. 40).

I-7. Secure the injection fitting with four layers of 3/4 in. plastic tape tightly stretched. Extend the tape 1/2 in. onto the sheath at both ends of the fitting (Fig. 41).

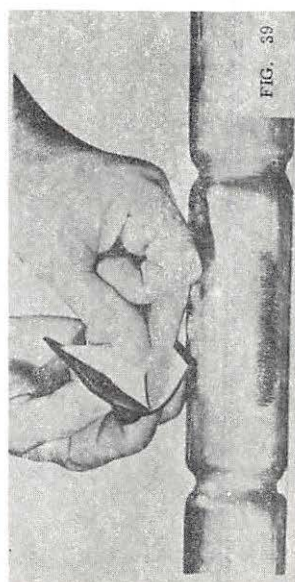
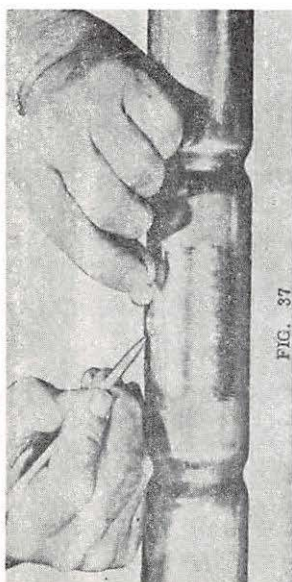
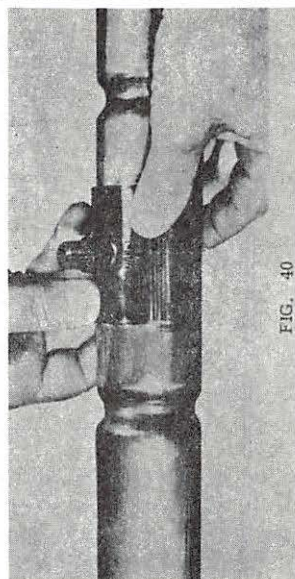
I-8. Mix Epoxy Resin No. 163 compound in the cartridge, as described in paragraph D-1 or D-7, whichever is applicable (Fig. 42).

I-9. After placing the mixed cartridge into the injection gun (paragraph E-3), screw the cartridge onto the threaded USF-1 sheath fitting (Fig. 43).

I-10. Inject the compound into the cable (Fig. 44). (The procedure of injecting the compound is covered in section M).

J--Dams--Stalpeth Cable

J-1. Make two constrictions 7 in. apart, using the constricting tool, in accordance with paragraphs F-5 and F-7.



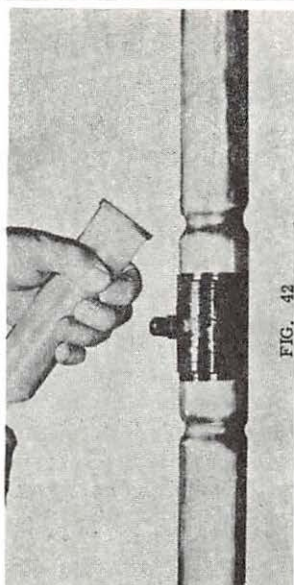


FIG. 42



FIG. 44

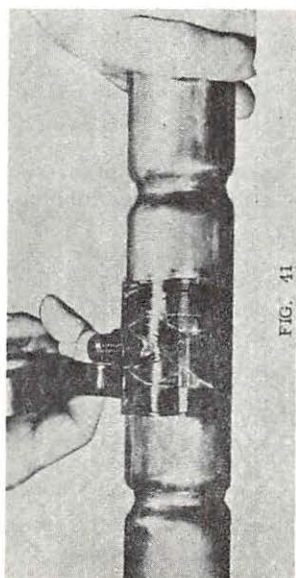


FIG. 41

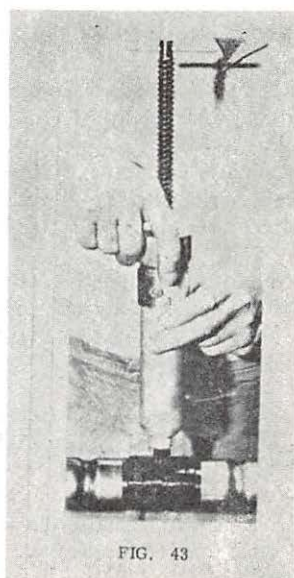


FIG. 43

J-2. Using a 1/4 in. cable drill, make four vent holes in the terneplate, one on each side of each constriction (Fig. 45). Do not damage the paper core-wrapper. After these vent holes have been drilled, puncture the paper core-wrapper with an orange stick. (These vent holes are required to allow compound to exude and completely fill the stripped sections of the sheath (Fig. 51), so as to prevent moisture entry between the outside sheath and the terneplate.)

J-3. With a file card, clean an area on the cable sheath large enough to accept the full base of the USF-1 sheath fitting midway between the constrictions (Fig. 46).

J-4. With a 3/8 in. cable drill, bore a hole only through the outside polyethylene jacket (Fig. 47). Remove the disc from the cable drill and then carefully drill through the steel terneplate. Exert only light pressure on the drill to avoid puncturing the paper core-wrapper and damaging the cable conductors. Once the terneplate is scored, remove the metal disc with long-nose pliers.

J-5. Before removing the paper core-wrapper, insert a "B" cable core depressor between the shield and wrapper and gently turn up the rough edges of shield and terneplate toward the opening (Fig. 48). This is to prevent any sharp edges from piercing the insulation of the cable conductors.

J-6. Perforate the paper core-wrapper with an orange stick and pick out the paper disc, being careful not to damage the conductor insulation (Fig. 49).

J-7. Insert the plastic channeling pins (Fig. 50), as described for LCPI cables in paragraph K-5.

J-8. Place five concentric wraps of 2 in. paper cable plasters, tightly wrapped, covering the sheath opening at the constrictions as shown in Fig. 51.

J-9. Remove the protective covering from the adhesive gasket backing of a USF-1 sheath fitting (Fig. 52). Center the fitting hole directly over the drilled hole in the cable sheath and apply pressure firmly to all sides of the fitting (Fig. 53).

J-10. Secure the injection fitting with four layers of 3/4 in. plastic tape tightly stretched. Extend the tape 1/2 in. onto the sheath at both ends of the fitting (Fig. 54).

J-11. Cover the 2 in. pasters with five layers of 1-1/2 in. plastic tape, tightly wrapped, extending 1/2 in. onto the taped portion of the injection fitting and 1 in. out on the cable sheath (Fig. 55).

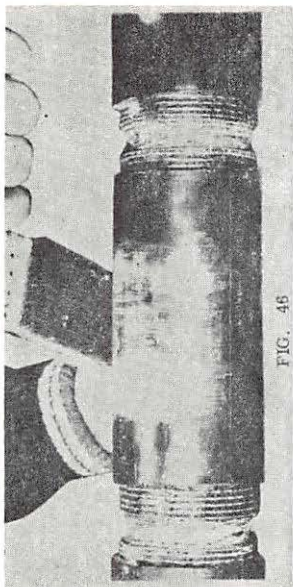


FIG. 46



FIG. 48

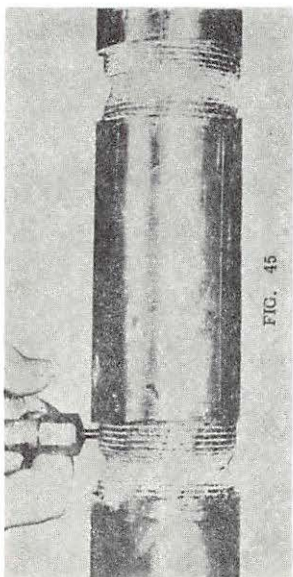


FIG. 45

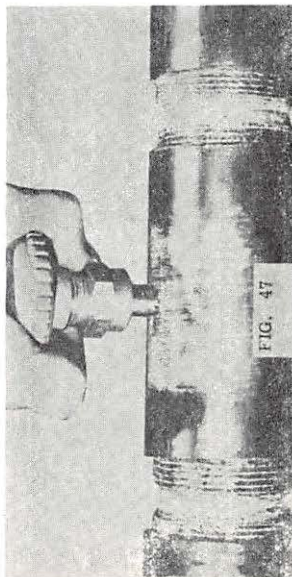


FIG. 47

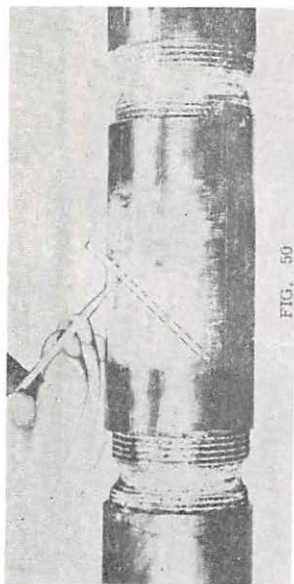


FIG. 50



FIG. 52



FIG. 49

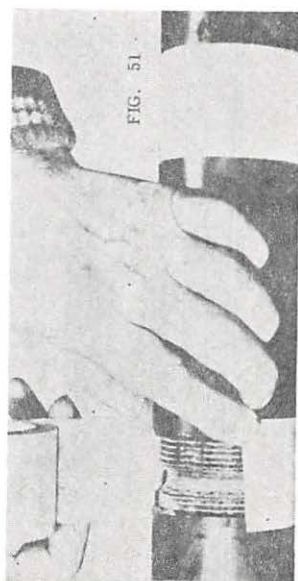


FIG. 51

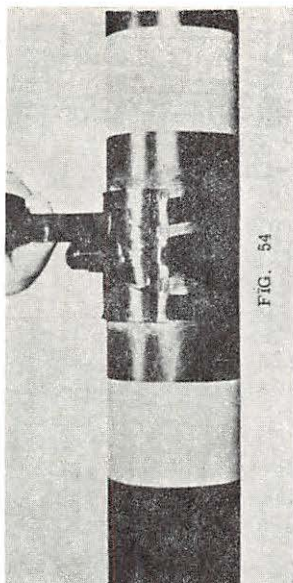


FIG. 54



FIG. 56

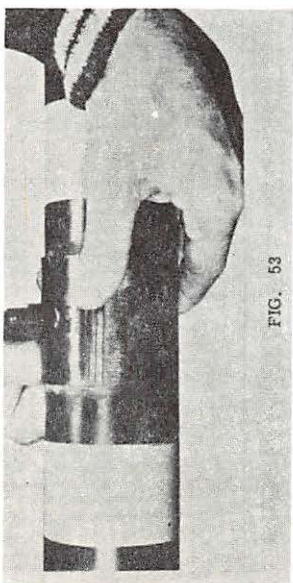


FIG. 53

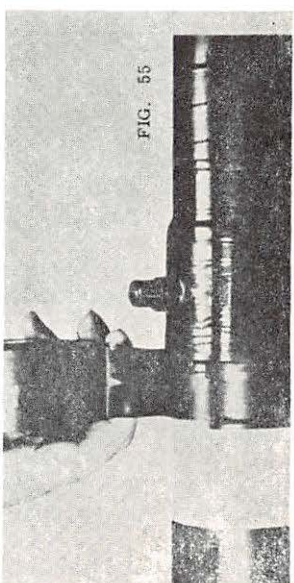


FIG. 55

J-12. Mix the compound as described in paragraph D-1 or D-7, whichever is applicable, and assemble the cartridge and injection gun (paragraph G-3). Screw the cartridge onto the USF-1 sheath fitting. Inject the compound as described in section M (Fig. 56).

K--Dams--Alpeth Cable

K-1. Make two sheath constrictions with two hose clamps (worm gear type) placed 6 in. apart, in accordance with paragraphs F-5 and F-11. The hose clamps will remain in place after the injection.

K-2. With a file card, clean an area on the cable sheath large enough to accept the full base of the USF-1 sheath fitting midway between the hose clamps (Fig. 57).

K-3. Drill a $\frac{3}{8}$ in. hole through the outer plastic sheath (Fig. 58), but do not penetrate the aluminum shield. Remove the aluminum shield and vinyl core-wrapper with an orange stick and long-nose pliers.

K-4. Channeling pins are not required for alpeth cable due to its loose core structure.

K-5. Place the USF-1 sheath fitting, following the steps outlined for stalpeth cable in paragraphs J-9 and J-10.

K-6. Mix the compound as described in paragraph D-1 or D-7, whichever is applicable, and assemble the cartridge and injection gun (paragraph E-2). Screw the cartridge onto the USF-1 sheath fitting. Inject the compound as described in section M (Fig. 59).

L--Dams--Textile-Insulated Cable

L-1. Make four constrictions, using the constricting tool, in accordance with paragraphs F-5 and F-14.

L-2. Clean an area on the sheath large enough to accept the full base of the USF-1 sheath fitting midway between the two inside constrictions (Fig. 60).

L-3. Drill a $\frac{3}{8}$ in. hole in the center of the cleaned area and place two channeling pins, following the instructions as previously outlined for LCPI cable in paragraphs I-3 to I-5, inclusive.

L-4. Place the USF-1 fitting (Fig. 61) and tape as described for LCPI cable in paragraphs I-6 and I-7.

L-5. Mix Epoxy Resin No. 163 compound as described in paragraph D-1 or D-7, whichever is applicable. Assemble the cartridge

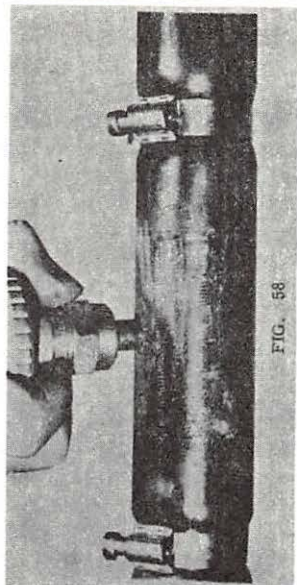


FIG. 58

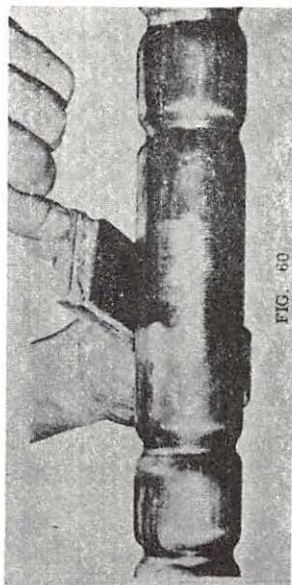


FIG. 60

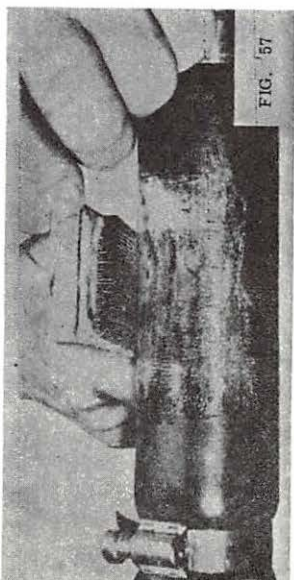


FIG. 57



FIG. 59

with the injection gun (paragraph E-2) and screw the cartridge onto the USF-1 sheath fitting.

L-6. Inject the compound as described in section M (Fig. 62). Due to the textile insulation and the double constrictions, the compound will not penetrate this type of cable as easily as other types. The injection of compound must be made very slowly so as to allow the back pressure to dissipate and the compound to properly penetrate the conductors. Refer to Table 1, following paragraph C-7, for approximate amount of compound and injection time required for different size cables.

M--Injection of Compound

M-1. Prior to injecting the compound into the cable for damming purposes, make sure the cable is free of air pressure. Follow the instructions for releasing air pressure as outlined in paragraph H-2.

M-2. Prepare the cable for compound injection (section I, J, K or L), and place the cable in its final permanent position.

M-3. Mix Epoxy Resin No. 163 compound and set up the injection gun (sections D and E).

M-4. Inject the compound into the cable slowly to allow it to thoroughly saturate the core and, in the case of paper-insulated conductors, penetrate the insulation. Generally, the compound should be injected at the rate of from 10 to 12 minutes per cartridge.

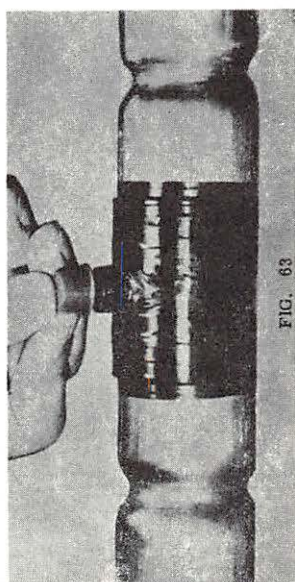
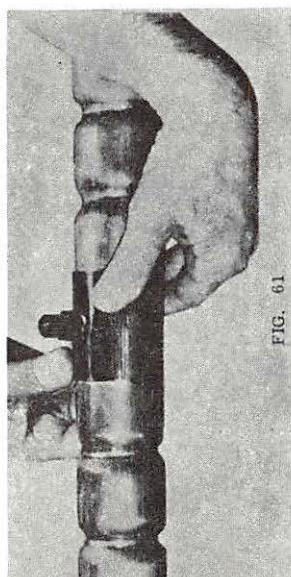
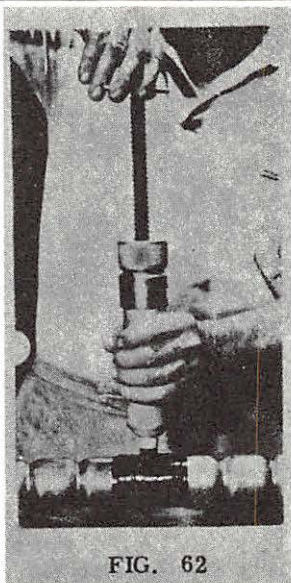
M-5. Do not exert excessive gun pressure when injecting the compound, as this could burst the cartridge or cause the compound to bypass the plunger in the cartridge.

M-6. Turn the handle on the pressure gun until a slight back pressure is felt, then allow several seconds for the compound to settle before again turning the handle. Repeat these operations throughout an injection.

M-7. If the cable to be injected requires slightly more than a 2-oz. cartridge, it is more economical to use a 6-oz. cartridge and throw away the excess compound than to use two 2-oz. cartridges.

M-8. After the compound has been injected, place the snap-on cap securely on the USF-1 fitting (Fig. 63). The cap may be placed lightly on the fitting to stop back-flow of compound during cartridge changes when necessary.

M-9. The compound pressure dam should not be moved until the compound hardens. Air pressure must not be reapplied until the



compound has hardened sufficiently. All air escape fittings placed for the operation must be left open for at least 24 hrs.

M-10. Remove cartridge from gun and discard used cartridge at the completion of the compound injection.

N--Faulty Pressure Dams

N-1. If the pressure dam is found faulty, after sufficient time is allowed for hardening of the compound, no attempt should be made to repair defective pressure dam. New dam should be installed 18 to 24 in. on either side of the faulty dam.

Appendix A

SPECIAL TOOLS REQUIRED FOR CABLE PRESSURIZATION

(Codings, unless otherwise specified, are those of General Machine Products catalog. Tools are available from other suppliers under the same coding.)

- (a) Gun, Injection No. 755; Semco.
- (b) Drill, Cable, 1/4 in.; GMPCO No. 6797.
- (c) Drill, Cable, 3/8 in.; GMPCO No. 7533.
- (d) Grip, Flange, C; Malor, Part No. 6.
- (e) Reducer, Nipple 1/4 in. to 1/8 in. Male Pipe Thread; Imp. Brass No. 123-B.
- (f) Pliers, Constriction, B-5245; Utica.
- (g) Depressor, "B" Cable Core; GMPCO No. 7064.
- (h) Constrictor, Cable Sheath; GMPCO No. 6978.
- (i) Apron, Compound Cartridge Warming; Rezolin Corp.

Appendix B

MATERIALS REQUIRED FOR CABLE PRESSURIZATION

(Codings, unless otherwise specified, are those of the General Machine Products catalog. Materials are available from other suppliers under the same coding.)

- (a) Compound No. 163--6 oz. Cartridge; Rezolin Corp.
- (b) Compound No. 163--2 oz. Cartridge; Rezolin Corp.
- (c) Fitting, Sheath, USF-1; Rezolin Corp.
- (d) Tape, Scotch Electric No. 33, 3/4 in.
- (e) Tape, Scotch Electric No. 22, 1-1/2 in.
- (f) Clamps, Hose (Various Sizes).
- (g) Paster, Gummed Paper, 2 in.
- (h) Pins, Plastic Channeling P-9.
- (i) Washer, Rubber "O" Ring, 316; Malor.

REPORT OF
COMMITTEE 2--PRACTICES AND OPERATION

A. J. Hendry (Chairman), Sig. Engr., Northern Pacific Ry.
B. Anderhous (Vice Chairman), Comms. Engr., Elgin, Joliet & Eastern Ry.
L. S. Bottinelli, Engr. - Comms. & Sigs., New York Central Sys.
E. A. Burgin, Engr. Sigs. & Comms., Chesapeake & Ohio Ry.
J. R. DePriest, Supt. Comms. & Sigs., Seaboard Air Line R.R.
L. H. Dyke, Chf. Comms. Engr., Erie Lackawanna R.R.
A. E. Emery, Supt., Telecomms. Dept., Canadian Pacific Ry.
A. L. Essman, Sig. Engr. Sys., Burlington Lines
H. E. Froyd, Mgr. - Comms., Opns. & Traffic, Union Pacific R.R.
E. L. Hite, Asst. Supt. Comms. - Traffic., Chicago, Rock Island & Pacific R.R.
R. D. Liggett, Chf. Engr., Comm. & Siglg., Atlantic Coast Line R.R.
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Consulting Members

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W. D. Orr, Mgr. Sys. Svcs., The Western Union Telegraph Co.

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.

4. Investigate and report on new signal and communication devices, methods and practices.
5. Study and report on a train hour value.
6. Cooperate with AREA Committee 18--Electricity.
7. Cooperate with AREA Committee 1--Roadway and Ballast, on reflectorized and luminous roadway signs.
10. Investigate and report on ways and means of interconnecting devices used to detect the presence of heat in journals or car wheels with signal systems and how the equipment is used when not so interconnected.
11. Investigate and report on methods to give warning of approaching trains to employees working on track.
12. Investigate and report on the use of facsimile for railroad communication services.
13. Investigate and report relative to the application of combined automatic business machines and teleprinter equipment for general communication work.
14. Investigate and report on the use of mechanical equipment for signal and communication construction and maintenance service.
19. Prepare and submit to the Committee of Direction, requisites for remote control of switching engines by inductive carrier.
20. Prepare and submit to the Committee of Direction, requisites for remote control of engines in switching operations by radio.
21. Investigate and report to the Committee of Direction on new developments for controlled operation of trains.
23. Prepare requisites for remote control, cab mounted switching signals for use in yards in lieu of hand or lantern signals.
24. Cooperate with AREA Committee 16--Economics of Railway Location and Operation, on assignment 5--Engineering Methods of Reducing Time of Freight Cars Between Loading and Unloading Points.
25. Prepare and submit to the Committee of Direction, requisites for remote control of engine helper in train.
26. Prepare and submit to the Committee of Direction, requisites for employing computers for automatic dispatching of trains.
27. Prepare and submit to the Committee of Direction, requisites for employing automatically controlled engines and trains.

The committee submits for consideration, reports on the following subjects.

1. Signal Manual Part 29 - Form 24--Economic Statement. The committee recommends that this manual part be eliminated from the Signal Manual and the information be included in the Rules for Standing Committees.

Action Recommended

Approval for elimination from the Signal Manual.

1. Signal Manual Part 86--Requisites for Traffic Control Systems, revised as shown in Exhibit 2-A, page 63.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 87--Requisites for Automatic Block Signaling Systems, revised as shown in Exhibit 2-B, page 67.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 94--Requisites for Interlocking, revised as shown in Exhibit 2-C, page 69.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 211--Requisites for Electric Locks Applied to Hand-Operated Switches for Protection of Main Track Movements, revised as shown in Exhibit 2-D, page 71.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 239--Requisites for Application of Fixed Signals, revised as shown in Exhibit 2-E, page 73.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Communication Manual Part 6-C-6--Standard Brevity Code. The committee recommends that this manual part be eliminated from the Communication Manual, as it is no longer needed.

Action Recommended

Approval for elimination from the Communication Manual.

4. Solid State Voltage Monitors, as Exhibit 2-F, page 82.

Action Recommended

Acceptance as information.

4. Adverse Effects of Magnetism in Rails, as Exhibit 2-G, page 84.

Action Recommended

Acceptance as information.

4. In 1966, Committee 2 presented a short report calling attention to difficulties encountered by a Southeastern Railroad with polarized d-c coded track circuits installed on welded rail, coral rock ballast and concrete ties. The General Railway Signal Company has conducted tests relative to the electrical characteristics of concrete ties and a report on their tests and findings can be obtained from the Secretary of the Section upon request.

Action Recommended

Acceptance as information.

5. Train Hour Value, as Exhibit 2-H, page 85.

Action Recommended

Acceptance as information.

12. Facsimile for Railroad Use, as Exhibit 2-I, page 87.

Action Recommended

Acceptance as information.

20. Requisites for Remote Control by Mobile Radio of Engine Performing Road Switching, as Exhibit 2-J, page 89.

Action Recommended

Approval for inclusion in the Communication Manual and the Signal Manual.

Respectfully submitted,

COMMITTEE 2--PRACTICES AND
OPERATION

Exhibit 2-A

(Revised Signal Manual Part 86)
AAR SIGNAL REQUISITES

TRAFFIC CONTROL SYSTEMS

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for traffic control systems. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Signals shall be in accordance with Application of Fixed Signals, Manual Part 239.

4. The battery or power supply for each signal control relay circuit, where an open-wire circuit or a common return circuit is used, shall be located at the end of the circuit farthest from the relay.

5. The control circuits for signal aspects with indications more favorable than "proceed at restricted speed" shall be selected through track relays for all track circuits in the route governed, or through repeating relays for such track relays. At controlled point, they may be controlled by control operator and, at manually-operated interlocking they shall be controlled manually in cooperation with control operator.

At automatic interlockings, signal control circuits shall be selected through:

(a) Track relays for all track circuits in the route governed, and in all conflicting routes within interlocking limits, or through repeating relays for such track relays.

(b) Signal mechanism contacts or relay contacts closed when signals for such conflicting routes display stop aspects.

(c) Normal contacts of time releases for such conflicting routes or contacts of relays repeating the normal position of contacts of such time releases.

6. On track signaled for movements in both directions, occupancy of the track between opposing signals at adjacent controlled points shall prevent changing the direction of traffic from that which obtained at the time the track became occupied, except that when a train having left one controlled point reaches a section of track immediately adjacent to the next controlled point at which switching is to be performed, an aspect permitting movement at not exceeding restricted speed may be displayed into the occupied block.

7. Signals at a controlled point shall be so interconnected that aspects to proceed cannot be displayed simultaneously for conflicting movements.

8. Signals at adjacent controlled points shall be so interconnected that aspects to proceed on tracks signaled for movements at greater than restricted speed cannot be displayed simultaneously for conflicting movements.

9. Means shall be provided to insure that after a signal has been cleared, and the locking is effective, it cannot be restored manually to Stop by the operation of any lever other than its controlling lever.

10. Signal governing movements over hand-operated switch in the facing direction shall display its most restrictive aspect when the closed point is open 1/4 in. or more and, in the trailing direction, 3/8 in. or more.

11. At hand-operated crossover between main tracks, protection shall be provided by one of the following:

(a) An arrangement of one or more track circuits, and switch circuit controllers.

(b) Facing point locks on both switches of the crossover, with both locks operated by a single lever.

(c) Electric locking of the switches of the crossover.

12. Signals governing movements over either switch of a hand-operated crossover shall display their most restrictive aspect when any of the following conditions exist:

(a) Where protection is provided by one or more track circuits and switch circuit controllers, and either switch is open or the crossover is occupied by a train, engine or car, in such a manner as to foul the main track.

(b) Where facing point locks with a single lever are provided, and either switch is unlocked.

(c) Where the switches are electrically locked, before the electric locking releases.

13. The circuits shall be so installed that each automatic block signal governing train movements into a block will display its most restrictive aspect when any of the following conditions exists within the blocks:

(a) Occupancy by a train, engine or car.

(b) When points of a switch are not closed in proper position.

(c) When an independently operated fouling point derail equipped with switch circuit controller is not in derailing position.

(d) When a track relay is in de-energized position, or when signal control circuit is de-energized.

14. The control circuit for each aspect with indication more favorable than "proceed at restricted speed" of a signal governing movements over switches and movable point frogs shall be selected through circuit controller operated directly by switch points or by switch locking mechanism, or through relay controlled by such circuit controller, for each switch and movable point frog in the routes governed by such signal. Circuits shall be arranged so that such

signal can display an aspect more favorable than "proceed at restricted speed" only when each switch and movable point frog in the route is in proper position.

15. Indication locking shall be provided in connection with home signals, power-operated switches and movable point frogs at controlled points, and operative approach signals, except light signals, all aspects of which are controlled by coded track circuits or by double-wire line circuits.

16. A signal shall be provided on main track to govern the approach with the current of traffic to any home signal at controlled points, except where the home signal is the first signal encountered when leaving yard or station and authorized speed approaching such signal is not higher than slow speed. When authorized speed between home signals on route governed is 20 mph or less, an inoperative signal displaying an aspect indicating "approach next signal prepared to stop" may be used to govern the approach to the home signal.

17. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is so arranged that it can in itself cause improper operation of the armature.

18. Occupancy of track circuits at controlled points shall be automatically indicated at the control station.

19. Approach or time locking shall be provided for all controlled signals.

20. Route locking shall be provided where switches are power-operated. Route locking shall be effective when the first pair of wheels of an engine or car passes a point not more than 13 ft. in advance of the signal governing its movements.

21. Means shall be provided to indicate on the control machine when power-operated switch has completed its movement and is locked.

22. Each hand-operated switch in main track shall be locked either electrically or mechanically in normal position, except where train speeds over switch do not exceed 20 mph, or where trains are not permitted to clear the main track at such switch.

23. At electrically or mechanically locked hand-operated switch in main track, approach or time locking shall be provided and locking may be released either automatically, or by the control operator, but only after the control circuits of signals governing movement in either direction over the switch and which display aspects with indications more favorable than "proceed at restricted speed" have been opened directly or by shunting of track circuit.

24. Spring switches shall be protected in accordance with Requirements for Protection at Spring Switches, Manual Part 10.

25. Power-operated switch mechanisms shall conform to Specification for Electro-Pneumatic Switch Operating Mechanism, Manual Part 30, or Specification for Electric Motor Switch Operating Mechanism, Manual Part 104.

26. Track circuits shall be in accordance with Requisites for Track Circuits, Manual Part 59.

Exhibit 2-B

(Revised Signal Manual Part 87)
AAR SIGNAL REQUISITES

AUTOMATIC BLOCK SIGNALING SYSTEMS

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for automatic block signaling systems. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Signals shall be in accordance with Application of Fixed Signals, Manual Part 239.

4. The battery or power supply for each signal control relay circuit, where an open-wire circuit or a common return circuit is used, shall be located at the end of the circuit farthest from the relay.

5. The control circuits for home signal aspects with indications more favorable than "proceed at restricted speed" shall be controlled automatically by track circuits extending through the entire block.

6. Signal governing movements over hand-operated switch in the facing direction shall display its most restrictive aspect when the closed point is open 1/4 in. or more and, in the trailing direction, 3/8 in. or more.

7. At hand-operated crossover between main tracks, protection shall be provided by one of the following:

(a) An arrangement of one or more track circuits and switch circuit controllers.

(b) Facing point locks on both switches of the crossover, with both locks operated by a single lever.

(c) Electric locking of the switches of the crossover.

8. Signals governing movements over either switch of a hand-operated crossover between main tracks shall display their most restrictive aspect when any of the following conditions exists:

(a) Where protection is provided by one or more track circuits and switch circuit controllers, and either switch is open or the crossover is occupied by a train, engine or car, in such a manner as to foul the main track.

(b) Where facing point locks with a single lever are provided, and either switch is unlocked.

(c) Where the switches are electrically locked, before the electric locking releases.

9. On track signaled for movements in both directions, a train shall cause one or more opposing signals immediately ahead of it to display the most restrictive aspect, the indication of which shall be not more favorable than "proceed at restricted speed." Signals shall be so arranged and controlled that if opposing trains can simultaneously pass signals displaying proceed aspects and the next signal in advance of each such signal then displays an aspect requiring a stop, or its most restrictive aspect, the distance between opposing signals displaying such aspects shall be not less than the aggregate of the stopping distances for movements in each direction. Where such opposing signals are spaced stopping distance apart for movements in one direction only, signals arranged to display restrictive aspects shall be provided in approach to at least one of the signals. Where such opposing signals are spaced less than stopping distance apart for movements in one direction, signals arranged to display restrictive aspects shall be provided in approach to both such signals. In absolute permissive block signaling when a train passes a head block signal it shall cause the opposing head block signal to display an aspect requiring a stop.

10. The circuits shall be so installed that each signal governing train movements into a block will display its most restrictive aspect when any of the following conditions obtains within the block:

- (a) Occupancy by a train, engine or car.
- (b) Points of a switch are not closed in proper position.
- (c) An independently operated fouling point derail equipped with switch circuit controller is not in derailing position.
- (d) A track relay is in de-energized position, or when signal control circuit is de-energized.

11. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is so arranged that it can in itself cause improper operation of the armature.

12. Signal control circuits shall be in accordance with Requisites for Automatic Block Signaling Circuits, Manual Part 34.

13. Track circuits shall be in accordance with Requisites for Track Circuits, Manual Part 59.

14. Spring switch signal shall be protected in accordance with Requisites for Protection at Spring Switches, Manual Part 10.

Exhibit 2-C

(Revised Signal Manual Part 94)
AAR SIGNAL REQUISITES

INTERLOCKING

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for interlocking. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. All control circuits, the functioning of which affects safety of train operation, shall be designed on the closed circuit principle, except circuits for roadway equipment of intermittent automatic train stop system.

3. Signals shall be in accordance with Application of Fixed Signals, Manual Part 239.

4. Track circuits and route locking shall be provided. Route locking shall be effective when the first pair of wheels of an engine or car passes a point not more than 13 ft. in advance of the signal governing its movement.

5. The control circuit for each aspect with indication more favorable than "proceed at restricted speed" of a signal governing movements over switches and movable point frogs shall be selected through circuit controller operated directly by switch points or by switch locking mechanism, or through relay controlled by such circuit controller, for each switch and movable point frog in the routes governed by such signal. Circuits shall be arranged so that such signal can display an aspect more favorable than "proceed at restricted speed." only when each switch and movable point frog in the route is in proper position.

6. The control circuits for aspects with indications more favorable than "proceed at restricted speed" shall be selected through track relays for all track circuits in the route governed, or through repeating relays for such track relays. At automatic interlocking, signal control circuits shall be selected through:

(a) Track relays for all track circuits in the route governed, and in all conflicting routes within interlocking limits, or through repeating relays for such track relays.

(b) Signal mechanism contacts or relay contacts closed when signals for such conflicting routes display stop aspects.

(c) Normal contacts of time releases for such conflicting routes or contacts of relays repeating the normal position of contacts of such time releases.

7. Approach or time locking shall be provided in connection with signals displaying aspects with indications more favorable than "proceed at restricted speed."

8. Indication locking shall be provided in connection with home signals, power-operated switches, movable point frogs and for operative approach signals, except light signals, all aspects of which are controlled by coded track circuits or by double-wire line circuits.

9. Signals shall be provided to govern train movements into and through interlocking limits, except that a signal shall not be required to govern movements over a hand-operated switch into interlocking limits if the switch is provided with an electric lock and a derail at the clearance point, either pipe-connected to the switch or independently locked, electrically. Where electric locks are so used they shall conform to time and approach locking of requisite 14 (without reference to the 20 mph exception).

10. Signals shall be controlled to prevent the display of aspects which permit conflicting movements except that opposing signals may display an aspect indicating "proceed at restricted speed" at the same time on a track used for switching movements only, by one train at a time.

11. At automatic interlocking, a loss of shunt for 5 seconds or less shall not permit an established route to be changed.

12. A signal shall be provided on main track to govern the approach with the current of traffic to any home signal except where the home signal is the first signal encountered when leaving yard or station and authorized speed approaching such signal is not higher than slow speed. When authorized speed between home signals on route governed is 20 mph or less, an inoperative signal displaying an aspect indicating "approach next signal prepared to stop" may be used to govern the approach to the home signal.

13. Signal control and electric locking circuits shall not be selected through the contacts of instruments designed primarily for indicating or annunciating purposes in which an indicating element attached to the armature is so arranged that it can in itself cause improper operation of the armature.

14. Electric lock shall be provided for each hand-operated switch within interlocking limits, except where train movements are made at not exceeding 20 mph. At manually-operated interlocking, it may be controlled by operator of the machine and shall be unlocked only after signals governing movements over such switch display aspects indicating stop. Approach or time locking shall be provided.

15. Track circuits shall be in accordance with Requisites for Track Circuits, Manual Part 59.

Exhibit 2-D

(Revised Signal Manual Part 211)
AAR SIGNAL REQUISITES

ELECTRIC LOCKS APPLIED TO HAND-OPERATED SWITCHES
FOR PROTECTION OF MAIN TRACK MOVEMENTS

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for electric locks applied to hand-operated switches for protection of main track movements. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. Electric locks shall be of the forced-drop type.

3. Control circuits shall be designed on the closed circuit principle.

4. Signals governing movements over electrically locked switches shall be so controlled that proper restrictive aspects will be displayed when electric lock is unlocked or switch is not in proper position.

5. Hand-operated electrically locked switches shall be locked in the normal position and in addition, where signaling provides for facing movements through switch reversed at medium or higher speed, switch shall be locked in the reverse position.

6. Electric locks may be provided with emergency means of unlocking, and operation of such device shall cause signals to display the proper restrictive aspects.

7. Electric locks may be controlled automatically, semiautomatically or manually. They may be controlled individually or in groups as local operating conditions permit.

8. Electric locks may be unlocked to permit train or engine to enter main track by either of the following:

(a) Without a time interval when approach control track circuits are unoccupied.

(b) After signal control circuits have been opened and after the expiration of a time interval determined in accordance with Instructions for Time Releases Applied to Signal Apparatus, Manual Part 128.

9. Electric locks may be unlocked to permit train or engine to leave main track by either of the following in addition to meeting the requirements for entering the track to which movement is to be made:

(a) Without a time interval by occupancy of short track circuit, preferably not exceeding 300 ft. in length, immediately in advance of the switch or by equivalent arrangement.

(b) After the expiration of a predetermined time interval when initiated manually at the switch, or initiated by occupancy of track circuit or circuits immediately in approach on the main track adjacent to the switch.

10. Where manually-controlled signals are used to govern movements toward an electrically locked switch, locks may be unlocked to permit train or engine to enter the main track when the following conditions are met:

- (a) Signals display their proper restrictive aspects.
- (b) Associated electric locking is released.
- (c) All track circuits between such signals and switch are unoccupied, except as provided in requisite 10-d-2.
- (d) The block being entered is either:
 - 1. Unoccupied and protected by a signal or signals displaying their proper restrictive aspects.
 - 2. Occupied by a train moving away from the switch.

Exhibit 2-E

(Revised Signal Manual Part 239)
AAR SIGNAL REQUISITES

APPLICATION OF FIXED SIGNALS

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for fixed signals. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. Each roadway signal shall be located so that it can be readily associated with the track on which it governs movement.

3. Aspects shall be shown by the position of semaphore blades, color of lights, position of lights, flashing of lights, or any combination thereof. They may be qualified by marker plate, number plate, letter plate, marker light, shape and color or semaphore blades, or any combination thereof, subject to the following conditions:

(a) Night aspects of roadway signals, except qualifying ap-purtenances, shall be shown by lights; day aspects by lights or semaphore arms. A single white light shall not be used.

(b) The fundamental indications of signal aspects shall conform to the following:

1. A red light, a series of horizontal lights, or a semaphore blade in a horizontal position shall be used to indicate Stop.

2. A yellow light, a lunar light, or a series of lights or a semaphore blade in the upper or lower quadrant at an angle of approximately 45 deg. to the vertical, shall be used to indicate that speed is to be restricted and stop may be required.

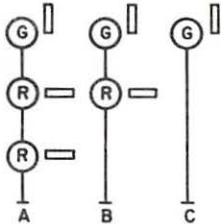
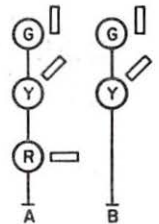
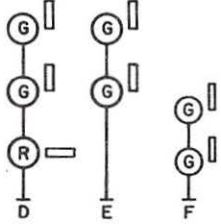
3. A green light, a series of vertical lights, or a semaphore blade in a vertical position in the upper quadrant, or 60 or 90 deg. in the lower quadrant shall be used to indicate Proceed at Authorized Speed.

(c) Typical aspects with AAR Standard Code Rules and Names are shown on pages 3 to 9, inclusive.

4. Each roadway signal shall be located with respect to the next signal or signals in advance which govern train movements in the same direction so that the indication of a signal displaying a restrictive aspect can be complied with by means of a brake application, other than an emergency application, initiated at such signal, either by stopping at the signal where a stop is required, or by a reduction in speed to the rate prescribed by the next signal in advance where reduced speed is required.

5. The failure of a lamp in a light signal, or a semaphore

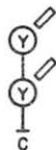
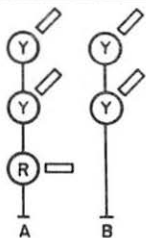
signal arm assuming a false restrictive position, shall not cause that signal to display a more favorable aspect than intended. When signal aspects are qualified by marker plates, number plates, letter plates, etc., and such appurtenances are obscured, a less restrictive aspect must not result.

AAR STANDARD CODE SIGNAL ASPECTS		
INSTRUCTIONS	RULE 281	RULE 281A
FIXED SIGNALS ASPECTS SHOWN ARE TYPICAL. EACH ROAD SHOULD SHOW THE ASPECTS AND COLORS OF LIGHTS IT USES. NOTE.-IN THE FOLLOWING ILLUSTRATIONS OF TYPICAL SIGNAL ASPECTS, RULES 281 TO 292, INCLUSIVE. R= RED Y= YELLOW G= GREEN NOTE.-WHEN THE COLOR "LUNAR" IS USED. L= LUNAR NOTE.-WHEN FLASHING COLOR LIGHTS ARE USED, THEY SHALL BE INDICATED AS FOLLOWS: FR= FLASHING RED FY= FLASHING YELLOW FG= FLASHING GREEN		
		
	INDICATION- PROCEED.	INDICATION- PROCEED APPROACHING SECOND SIGNAL AT MEDIUM SPEED.
	NAME: CLEAR.	NAME: ADVANCE APPROACH MEDIUM.

AAR STANDARD CODE SIGNAL ASPECTS		
RULE 28iB	RULE 28iC	RULE 282
INDICATION- PROCEED APPROACHING NEXT SIGNAL AT LIMITED SPEED.	INDICATION - PROCEED; LIMITED SPEED WITHIN INTERLOCKING LIMITS.	INDICATION - PROCEED APPROACHING NEXT SIGNAL AT MEDIUM SPEED.
NAME: APPROACH LIMITED	NAME: LIMITED - CLEAR	NAME: APPROACH MEDIUM

AAR STANDARD CODE SIGNAL ASPECTS

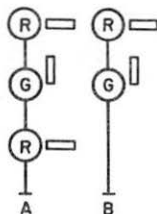
RULE 282A



INDICATION-PROCEED PREPARING
TO STOP AT SECOND SIGNAL.

NAME: ADVANCE APPROACH.

RULE 283



INDICATION-PROCEED; MEDIUM
SPEED WITHIN INTERLOCKING
LIMITS.

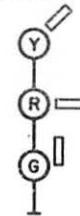
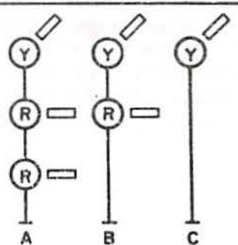
NAME: MEDIUM-CLEAR.

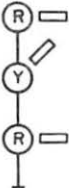
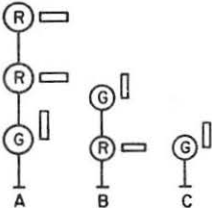
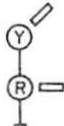
RULE 283A



INDICATION-PROCEED PREPARING
TO STOP AT SECOND SIGNAL;
MEDIUM SPEED WITHIN
INTERLOCKING LIMITS.

NAME: MEDIUM-
ADVANCE APPROACH.

AAR STANDARD CODE SIGNAL ASPECTS		
RULE 283B.	RULE 284	RULE 285
		
INDICATION- PROCEED AT MEDIUM SPEED APPROACHING NEXT SIGNAL AT SLOW SPEED.	INDICATION-PROCEED APPROACHING NEXT SIGNAL AT SLOW SPEED. TRAIN EXCEEDING MEDIUM SPEED MUST AT ONCE REDUCE TO THAT SPEED.	INDICATION-PROCEED PREPARING TO STOP AT NEXT SIGNAL. TRAIN EXCEEDING MEDIUM SPEED MUST AT ONCE REDUCE TO THAT SPEED.
NAME: MEDIUM-APPROACH SLOW.	NAME: APPROACH SLOW.	NAME: APPROACH.

AAR STANDARD CODE SIGNAL ASPECTS		
RULE 286	RULE 287	RULE 288
		
INDICATION-PROCEED AT MEDIUM SPEED PREPARING TO STOP AT NEXT SIGNAL.	INDICATION-PROCEED; SLOW SPEED WITHIN INTERLOCKING LIMITS.	INDICATION-PROCEED PREPARING TO STOP AT NEXT SIGNAL; SLOW SPEED WITHIN INTERLOCKING LIMITS.
NAME: MEDIUM-APPROACH.	NAME: SLOW-CLEAR.	NAME: SLOW-APPROACH.

AAR STANDARD CODE SIGNAL ASPECTS

RULE 289

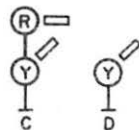
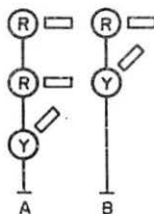


DESIGNATE BY: 1-LETTER PLATE
OR
2-MARKER LIGHT
OR
3-SHAPE OF ARM
OR
4-COMBINATION OF
THESE DISTIN-
GUISHING FEATURES.

INDICATION-MANUAL BLOCK
OCCUPIED; PROCEED PREPARED
TO STOP SHORT OF TRAIN OR
OBSTRUCTION, BUT NOT EXCEED-
ING 15 MILES PER HOUR.

NAME: PERMISSIVE.

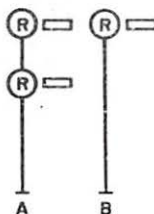
RULE 290



INDICATION- PROCEED AT
RESTRICTED SPEED.

NAME: RESTRICTING.

RULE 291



DESIGNATE BY: 1-NUMBER PLATE
OR
2-MARKER LIGHT
OR
3-POINTED BLADE
OR
4-COMBINATION OF
THESE DISTIN-
GUISHING FEATURES.
NOTE-RAILROADS DESIRING TO AVOID
STOPPING TRAINS MAY ARRANGE
ACCORDINGLY.

INDICATION- STOP; THEN PROCEED
AT RESTRICTED SPEED.

NAME: STOP AND PROCEED.

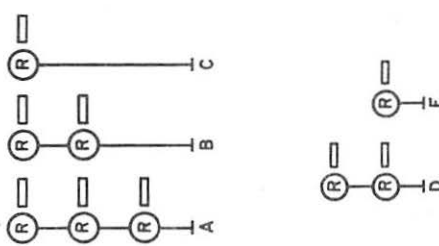
AAR STANDARD CODE SIGNAL ASPECTS		
RULE 292		INDICATION - STOP.
		NAME: STOP.

Exhibit 2-F

SOLID STATE VOLTAGE MONITORS

A solid state voltage monitoring device is available to maintain continuous surveillance over power supply voltages so that a change beyond predetermined limits can be detected. Two basic types are available, one for monitoring a-c voltages and the other for monitoring d-c voltages. Circuit arrangements are available for each model to accommodate a variety of applications. Basically, these devices respond when the monitored voltage either exceeds or falls below a predetermined limit at which time a self-contained, electromagnetic relay is actuated. Two front-back contacts are available for controlling external circuits. Relay contacts are adequate to control 1 amp at 125 d-c or 10 amps at 115 volts, 60 Hz. Response time is 50 milliseconds for the a-c model and 10 milliseconds for the d-c model. The device is available for operation from various a-c and d-c supply voltages. A 12-volt, d-c model consumes 3 watts.

The device is a high gain amplifier with reference power supplies. The trigger voltage is adjustable as is also the restoring voltage. The latter can be adjusted so that the circuit must be manually restored. The unit shown in Fig. 1 may be either wall mounted or panel mounted, outside dimensions are approximately 2 in. by 4 in. by 10 in.

Typical applications of this device are as follows:

Electric Track Switch Heater Fault Detection.

Faults occasionally develop in electric track switch heaters which do not, at first, cause overload detection to be actuated but at the same time may become hazardous to anyone coming in direct contact with the energized rail. Effective ground fault detection can be accomplished with the monitor device. Experience indicates the trip voltage can be adjusted to approximately 15 volts for reliable operation and the restoring voltage (dead band adjustment) set at maximum in order to prevent automatic restoring. In CTC territory, circuits to the switch heater control relay and the power-off indication relay are interrupted, thereby de-energizing the switch heaters and causing a power-off indication to be displayed at the Control Center. After the winter season passes, these devices are disconnected from the track to avoid damage from lightning surges.

Rail Temperature Limiter for Track Switch Heaters.

Temperature limits of rail where track switch heaters are applied can be controlled by utilizing thermal-ribbon, resistance-type sensors attached directly to the web of the rail by

an adhesive process. The change of resistance of the sensors is used to produce a change in the input voltage to the monitoring device, thereby enabling establishment of operating temperature limits of the rail. In this application, the restoring feature (dead band adjustment) is utilized to reclose the heater control circuits when rail temperature declines.

Battery Voltage Monitor.

Although there are means of maintaining battery voltages at predetermined levels through constant voltage rectifiers or other similar devices, these devices have no provision for initiating a warning when they fail to function. Used as an independent monitor, an indication can be initiated whenever battery voltages decline below safe limits.

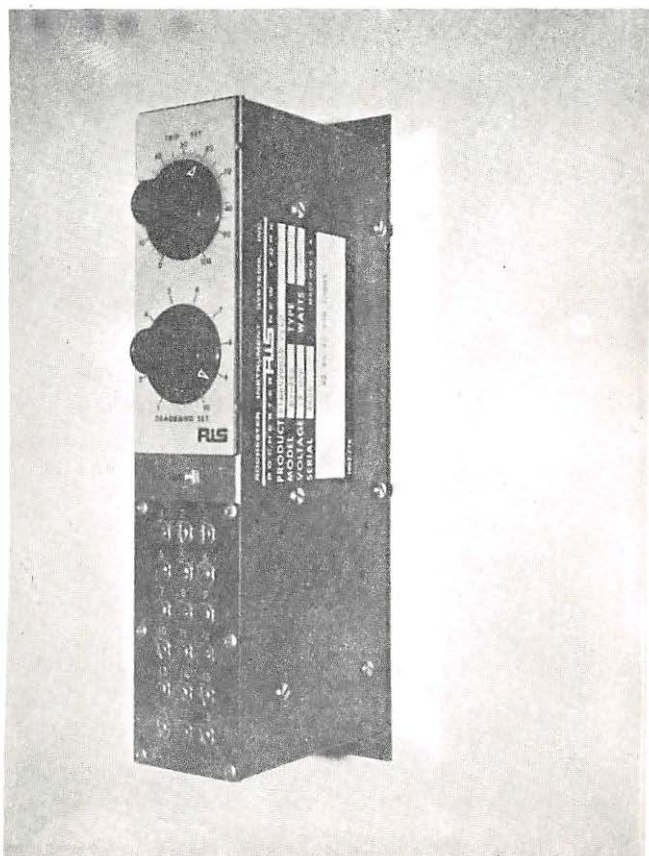


Exhibit 2-G

ADVERSE EFFECTS OF MAGNETISM IN RAILS

Several railroads have reported problems caused by magnetized rail. When the rail is magnetized, rail ends accumulate iron particles from brake shoe, flange and tread wear that may bridge insulated joints and may result in the display of false signal aspects. Iron particles have also adhered to rail in a manner to allow track current to bypass a broken rail. Magnetized rail has also caused unwanted operation of automatic train stop equipment, resulting in unnecessary train delays.

Rail test cars constitute the principle cause of magnetized rail, and when this problem arose many years ago, it was solved by equipping the test cars with coils on the rear to demagnetize the rail after testing. This feature is not available on the smaller rail-highway type test cars and the rail may be left in a highly magnetized condition.

Exhibit 2-H

TRAIN HOUR VALUE

At the 1966 Annual Meeting* the committee submitted a report and presented Table II for the calendar year 1964. A revision of Table II for the calendar year 1965 is herein presented. As shown, total train hour cost (excluding train crew wages) for the year 1965 varied from a minimum of \$0.85 to a maximum of \$91.45.

TABLE II

Specified Elements of Train Hour Cost Per Road
Freight Train Hour--Year 1965
(Excluding road freight train crews' wages)

Railroad	Elements of train hour cost (per road freight train hour)			
	Fuel Supplies, enginehouse expense and locomotive repairs	Road freight loco- motive depre- ciation	Payroll taxes on labor applicable to road freight loco. repairs & enginehouse expense <u>a</u>	Total train hour cost (excluding train crew wages)
1	2	3	4	5=2+3+4
Item number **	Items 2 to 8	Item 9	Item 11	Items 2 to 11
<u>EASTERN DISTRICT (Incl. Poca. Reg.):</u>				
1 Akron, Canton & Youngstown	\$ 0.73	\$ 0.10	\$0.02	\$ 0.85
2 Ann Arbor	27.04	5.80	0.68	33.52
3 Baltimore & Ohio	41.92	1.50	1.09	44.51
4 Bangor & Aroostook	37.51	6.22	1.13	44.86
5 Bessemer & Lake Erie	52.14	10.33	1.44	63.91
6 Boston & Maine	32.50	6.19	0.98	39.67
7 Canadian Pacific (Lines in Me.)	23.60	0.40	0.56	24.56
8 Central RR of New Jersey	22.52	3.74	0.70	26.96
9 Central Vermont	30.68	-	0.85	31.53
10 Chesapeake & Ohio	39.57	8.26	0.90	48.73
11 Chicago & Eastern Illinois	38.81	6.19	0.78	45.78
12 Chicago & Illinois Midland	47.84	8.91	1.11	57.86
13 Delaware & Hudson	47.62	10.19	1.19	59.00
14 Detroit & Toledo Shore Line	26.00	4.44	0.42	30.86
15 Detroit, Toledo & Ironton	23.39	4.21	0.59	28.19
16 Elgin, Joliet & Eastern	28.25	-	0.85	29.10
17 Erie-Lackawanna	38.15	6.24	0.97	45.36
18 Grand Trunk Western	51.12	-	1.17	52.29
19 Illinois Terminal	45.92	4.43	1.19	51.54
20 Lehigh Valley	49.30	6.94	1.17	57.41

a Payroll taxes calculated on total payroll at a rate of 8.25 per cent. Reduction in actual rate of 12.125 percent effective from Jan. 1-Oct. 31 and 11.125 percent effective from Nov. 1-Dec. 31 account monthly compensation in excess of \$450 per month.

* 1966 Annual Meeting Advance Reports, p. 95.

** See Chapter III--Principles and Economics of Signaling, American Railway Signaling Principles and Practices, p. 20.

Communication and Signal Section, AAR
2--Practices and Operation

TABLE II--Continued

21	Long Island	25.61	1.02	0.85	27.48
22	Maine Central	31.57	5.57	1.03	38.17
23	Monon	31.91	7.24	0.78	39.93
24	New York Central	51.74	7.39	1.39	60.52
25	New York, New Haven & Hartford	45.37	9.01	1.34	55.72
26	Norfolk & Western	42.74	7.98	0.93	51.65
27	Pennsylvania	39.06	5.03	1.14	45.23
28	Penna-Reading Seashore Lines	19.77	2.41	0.64	22.82
29	Pittsburgh & Lake Erie	78.45	0.08	1.73	80.26
30	Reading	33.25	12.94	0.98	47.17
31	Richmond Fred'burg & Potomac	77.71	11.91	1.83	91.45
32	Western Maryland	41.57	7.03	1.25	49.85
<u>SOUTHERN DISTRICT</u>					
33	Alabama Great Southern	39.23	11.96	1.03	52.22
34	Atlantic Coast Line	34.00	5.22	0.95	40.17
35	Central of Georgia	21.63	4.61	0.73	26.97
36	Cincinnati, New Orleans & T.P.	38.66	16.48	1.09	56.23
37	Clinchfield	44.98	8.37	1.12	54.47
38	Florida East Coast	37.25	8.23	1.00	46.48
39	Georgia	22.61	4.05	0.61	27.27
40	Georgia Southern & Florida	25.54	2.73	0.72	28.99
41	Gulf, Mobile & Ohio	34.78	7.11	0.93	42.82
42	Illinois Central	37.35	5.73	0.77	43.85
43	Louisville & Nashville	35.44	6.36	0.74	42.54
44	New Orleans & Northeastern	42.73	19.03	1.24	63.00
45	Norfolk Southern	17.67	6.05	0.40	24.12
46	Piedmont & Northern	8.47	2.04	0.27	10.78
47	Seaboard Air Line	38.77	7.89	0.95	47.61
48	Southern	22.86	7.98	0.61	31.45
<u>WESTERN DISTRICT</u>					
49	Atchison, Topeka & Santa Fe Sys.	51.21	\$ 8.88	\$1.30	\$61.39
50	Chicago & North Western	34.25	6.10	0.88	41.23
51	Chicago, Burlington & Quincy	39.39	6.65	0.84	46.88
52	Chicago Great Western	38.08	9.29	1.00	48.37
53	Chicago, Milwaukee, St. P. & P.	45.58	7.53	1.01	54.12
54	Chicago, Rock Island & Pacific	35.38	4.26	0.80	40.44
55	Colorado & Southern	35.79	12.23	0.84	48.86
56	Denver & Rio Grande Western	44.86	8.09	1.05	54.00
57	Duluth, Missabe & Iron Range	38.42	30.43	0.70	69.55
58	Duluth, Winnipeg & Pacific	45.62	-	1.35	46.97
59	Fort Worth & Denver	39.32	4.28	0.99	44.59
60	Great Northern	46.41	6.88	1.08	54.37
61	Kansas City Southern	57.83	8.40	1.56	67.79
62	Lake Superior & Ishpeming	17.80	4.22	0.54	22.56
63	Louisiana & Arkansas	44.34	6.06	1.16	51.56
64	Missouri-Kansas-Texas	35.24	6.15	1.02	42.41
65	Missouri Pacific	43.16	6.87	1.17	51.20
66	Northern Pacific	42.03	7.54	0.89	50.46
67	Northwestern Pacific	29.12	-	0.96	30.08
68	St. Louis-San Francisco	39.21	6.39	0.82	46.42
69	St. Louis Southwestern	47.43	7.79	0.95	56.17
70	Soo Line	33.40	5.86	0.80	40.06
71	Southern Pacific (Incl. Pac. Elec.)	63.15	11.11	1.77	76.03
72	Spokane, Portland & Seattle	25.48	4.40	0.71	30.59
73	Texas & Pacific	41.68	9.11	1.13	51.92
74	Toledo, Peoria & Western	27.71	5.32	0.62	33.65
75	Union Pacific	65.11	17.68	1.46	84.25
76	Western Pacific	60.80	8.43	1.53	70.76
<u>Averages by Districts:</u>					
	Eastern District	37.46	5.52	0.98	43.96
	Southern District	32.75	6.82	0.80	40.37
	Western District	47.88	8.77	1.19	57.84
	United States	41.00	7.10	1.03	49.13

Exhibit 2-I

FACSIMILE FOR RAILROAD USE

The 1950 Proceedings reported that no facsimile sets were available for railroad use. The 1952 Proceedings reported that the Western Union Telegraph Company had developed a facsimile system that would be available to railroads on reasonable notice. The 1955 Proceedings gave the transmission requirements for facsimile. The 1958 Proceedings reported among other things that "many firms have found facsimile equipment provides an economical and rapid means of pickup and delivery of messages at communication centers. Railroads can use this equipment to supplant messenger service in large terminals and buildings." The 1959 Proceedings listed other types of facsimile equipment available. The 1962 Proceedings described a facsimile system in use between yard offices to transmit information about freight train consists.

There are two railroads that have reported using high-speed facsimile systems to transmit all or parts of waybills in lieu of more conventional transmission of train consists. These systems require a very wide bandwidth communications system.

There are some slower-speed facsimile systems in use between telegraph offices and yard offices to transmit messages. There are other systems in use to transmit the bill of lading or bill of lading information from the freight house or other delivery point to the yard office where the information is used to prepare the actual waybill.

One railroad reported a facsimile system in use over their own communications lines. It consists of both 3 minute and 1.2 minute per letter size (8 1/2 in. by 11 in.) page equipment, depending on the volume. The facsimile traffic includes engine, situation, caboose and piggyback reports; car location information; charts; drawings; letters; contracts; telegrams; etc. This facsimile system affords quick and accurate reproduction of original documents and eliminates the necessity of typing, retyping or tape preparation, and associated delays and inaccuracies. The engine, situation, caboose, and piggyback reports are handwritten on specially designed forms. Incoming copies of facsimile reports are easily duplicated on photo-static type equipment.

One manufacturer has announced the availability of a high-speed facsimile system capable of transmitting up to 8.75 letter size documents per minute on a 240-kHz channel, or 1.75 letter size documents per minute on a 48-kHz channel using 135 lines per inch resolution. Improving the resolution to 190 lines per inch would reduce the speeds to 4.38 and 0.88 documents per minute.

A slow-speed facsimile system has recently become available. This system is specifically designed to be used with ordinary telephones. The equipment includes a special stand in which a standard telephone handset is placed after a telephone connection is established and verbal arrangements have been made to transmit a document. This equipment is slow and sends at the rate of 1.85 in. per minute. The receiver uses a throwaway carbon paper in combination with a copy paper. The copy is printed by a mechanical device being driven against the carbon paper.

Facsimile is a fertile field for expansion on the railroad, because any type of writing, drawing or copies can be transmitted. The bandwidth of the available communications systems has been a limiting factor. However, as the cost of broadband channels has decreased, the development of high-speed facsimile has expanded and improved. Use of facsimile systems could follow very closely the expansion of microwave installations on the railroads.

Exhibit 2-J

AAR COMMUNICATION AND SIGNAL REQUISITES

REMOTE CONTROL BY MOBILE RADIO OF ENGINE
PERFORMING ROAD SWITCHING

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for remote control by portable radio equipment of an engine when performing road switching. They set forth specific detail requirements representing modern communication and signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.
2. System shall provide for the remote control of the following, where required:
 - (a) Direction.
 - (b) Throttle.
 - (c) Engine brakes.
 - (d) Train brakes (emergency and service application, lap and release).
 - (e) Horn.
 - (f) Bell.
 - (g) Rail sander.
 - (h) Headlight.
3. The combined controller and transmitter shall be portable and of such size, weight and design as to permit it being carried or worn without interference to vision, hearing, mobility or such activities as throwing track switches by hand, using a telephone, coupling or uncoupling cars, climbing upon engine or cars, or entering an engine cab.
4. The combined controller and transmitter shall be powered by a lightweight battery which is to be normally charged from the engine power supply when the unit is in its storage rack located on the engine.
5. System shall be designed so that conventional propulsion control equipment and auxiliary equipment, such as automatic train stop and train control equipment, dead man control located on the engine, etc., will be ineffective when engine is in the remote control mode.

6. The combined controller and transmitter shall include means to stop the engine if the bearer falls or becomes disabled.

7. Transmission power shall be adequate to provide reliable control from all points in line-of-sight within 2000 ft. of the engine, but the input power to the final stage shall not exceed 3 watts.

8. The radio carrier shall be on a frequency in the VHF or UHF band which is allocated by governmental agency for use by railroads and which is approved by that agency for use in remote control of engines. The carrier shall be modulated to provide all the necessary individual control signals. The equipment shall be designed to use the minimum spectrum space consistent with performance required by these requisites.

9. Remote control equipment for location on the engine shall be so designed that it can be installed so as not to interfere with conventional control equipment.

10. System shall be designed so that a failure will not cause an unsafe condition. When the normal modulated control carrier is not present at the engine receiver, the controls shall operate to apply the brakes and cut off the power.

11. System shall be designed to minimize interference from other remote control and communication systems, if any, in the same general area, and shall be designed so that such interference will not cause an unsafe condition.

12. System shall be designed to limit the engine to a speed not to exceed 20 mph when it is in the remote control mode.

13. System shall be designed to insure that engine has stopped before power can be applied for movement in the opposite direction.

14. Throttle control shall be designed to advance or retard throttle in discrete steps or "notches" on engines using this type of control.

15. The radio equipment shall be capable of compliance with all applicable governmental rules, regulations and standards in effect at time of delivery.

16. Where required, a single alarm device, visible or audible from a distance of 2000 ft. under normal conditions, shall be located on the engine to provide warning of low air pressure and other abnormal conditions.

REPORT OF
COMMITTEE 3--ELECTRONICS

- W. B. Garrison (Chairman), Proj. Engr. - Comms. & Sigs., New York Central R.R.
G. M. Hill (Vice Chairman), Sig. Engr., Chicago, Milwaukee, St. Paul & Pacific R.R.
J. M. Beavers, Engr. of Sigs. - Const. & Maint., Baltimore & Ohio R.R.
R. B. Blaylock, Comms. Supvr. - Sys., St. Louis-San Francisco Ry.
H. H. Dofka, Regl. Sig. Engr., Canadian National Rys.
C. H. Dunn, Prin. Asst. Sig. Engr., Northern Pacific Ry.
B. Freeman, Engr. Comms. & Sigs., Pennsylvania R.R.
W. H. Martin, Supt. Sigs. & Telephone, Union R.R.
J. T. Mattison, Asst. to Vice Pres. - Sigs. & Elecl., Southern Ry.
B. L. McNeill, Jr., Supt. of Comms. & Sigs., Western Pacific R.R.
H. S. J. Minkes, Comms. Engr. - Electronics, Chesapeake & Ohio Ry.
W. Poole, Jr., Engr. Sig. Design, Chicago, Burlington & Quincy R.R.
W. J. Young, Engr. Sigs. & Comms., Bessemer & Lake Erie R.R.

Consulting Members

- J. A. Cook, Jr., Mgr., Prod. Dvlpt. Engrg., Union Switch & Signal Div. of Westinghouse Air Brake Co.
R. B. Haner, Prod. Engr. - Train Detection, General Railway Signal Co.

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.
4. Report on electronic measuring apparatus applicable to communications and signaling.

5. Investigate and report on principles of detecting the presence of heat in journals or car wheels.

6. Investigate and report on the use of solid state devices for communication or signaling purposes.

7. Investigate and report on the use of electronic controls for railway signaling, and if deemed desirable, recommend basic design principles for electronic controls for railway signaling systems.

10. Investigate and report on the use of electronic or other similar devices that may be used for car and/or train identification.

12. Investigate and report on, and prepare requisites for, inductive pick-up loop used in connection with audio-frequency overlay type apparatus.

The committee submits for consideration, reports on the following subjects:

1. Military Specifications and Standards, as Exhibit 3-A, page 93.

Action Recommended

Acceptance as information.

4. FM Communications Monitor-Generator, as Exhibit 3-B, page 95.

Action Recommended

Acceptance as information.

5. Hot Journal Detector, as Exhibit 3-C, page 98.

Action Recommended

Acceptance as information.

7. Loop for Audio Frequency Overlay Equipment, as Exhibit 3-D, page 108.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 3--ELECTRONICS

Exhibit 3-A

MILITARY SPECIFICATIONS AND STANDARDS

In day-by-day Communication and Signal activities, the concept of "Mil-Specs" (Military Specifications and Standards) employed in regard to a technical description pertaining to the characteristics of a specific piece of material or equipment is often encountered. For those who require a knowledge of the actual text or product specification outlined by a particular Mil-Spec, the following is background information concerning their availability.

There are in excess of 33,000 unclassified military specifications for which an index in two volumes is available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402, under the following title:

Department of Defense - Index of Specifications and Standards
Part I Alphabetical Listing (by subject) 900 + pages
Part II Numerical Listing (by spec. number) 1183 + pages

The annual subscription for this index is \$20, which includes cumulative bimonthly supplements for each part.

Automatic mailing of standardization documents, listed in the index, is available to non-government activities. Subscriptions will be accepted by Director, U. S. Navy Publications and Printing Service Office, 700 Robbins Ave., Philadelphia, Pa. 19111, based on Federal Supply Classifications (FSC). A service charge of \$4.50 per class per year will apply without regard to the number of documents which may be issued.

Electrical components are sometimes listed in more than one Federal Supply Classification. For example, a resistor generally is listed under FSC 5905; however, there are other types of special purpose resistors carried under the FSC of the particular item of which they are a component.

As further example of Federal Supply Classifications, the majority of capacitors are carried under FSC 5910. Relays FSC 5945 and electron tubes are carried in FSC 5960.

The majority of book type Mil-Specs may be purchased from the Superintendent of Documents, U. S. Government Printing Office. Industry-approved standardization documents are generally available from the specific industry association which sponsored the standard.

Individual unclassified random Mil-Specs, not included in the categories above, are stocked by the Commanding Officer, U. S. Naval

Supply Depot (NSD 103), 5801 Tabor Ave., Philadelphia, Pa. 19120. Federal Specifications and Standards and Military Book Form Standards will not generally be furnished by the Naval Supply Depot to commercial firms unless required in connection with a bid or contract, or for other sufficient justification.

The previously mentioned Department of Defense - Index of Specifications and Standards indicates the distribution point or source of individual Mil-Specs. When a request is made to the U. S. Naval Supply Depot at Philadelphia, Pa., with sufficient justification, an individual letter of request on company letterhead is acceptable. However, Department of Defense Form 1425 is preferred for requisitioning Standardization Documents.

Exhibit 3-B

FM COMMUNICATIONS MONITOR-GENERATOR

A new solid state communication monitor-generator, designed for checking the frequency and deviation of transmitters and for aligning and checking the sensitivity of receivers operating in the FM bands, is available.

Although this unit is designed to check the frequency and FM deviation of transmitters operating within the FM communication bands, it can also generate FM and CW signals within those bands. Frequencies in the range of 100 Hz to 10 MHz and beyond can be generated for receiver IF (Intermediate Frequency) test and other purposes.

Any frequency in the communication spectrum can be set up on a six-digit frequency selector to measure or generate that channel. Transmitter frequency error is indicated on a full scale reading of ± 1.5 , 5.0, or 15 kHz and the FM modulation is indicated on a modulation deviation meter with a full scale reading of 2.5, 6.0 and 25 kHz. Peaks exceeding a preset amount will cause a deviation peak lamp to flash. A scope jack provides for visual observation of the incoming modulation wave form.

Signal generator output is variable from 0.1 to 100 microvolts through a 20-db pad supplied with the instrument for preventing damage to the instrument if a transmitter is inadvertently keyed.

The crystal oscillator is easily set for calibration against WWV. Signal pickup and radiation are either through a telescoping antenna or cable. Accuracy is maintained between ambient temperature of zero C (32F) to 55C (131F) by means of the control oscillator crystal in a thermostatically-controlled oven.

An accessory deviation calibrator permits calibration of the FM deviation meter ranges.

An accessory Decade Frequency Divider provides submultiples of the IF frequencies of the unit to check tone frequency operated receivers and other low-frequency devices.

Two models essentially the same except for the frequency bands covered are available. These models have the following characteristics:

	Model A	Model B
Frequency Coverage	30- 90 MHz* 130-190 MHz* 430-490 MHz* <u>930-990 MHz</u> * Optional	20- 80 MHz* 120-180 MHz* 420-480 MHz* 920-980 MHz
Accuracy of Frequency Measurements	0.0001 percent Long Term	
Frequency Meter Resolution	50 Hz	
Monitor		
Sensitivity	Less than 10 millivolts at all frequencies	
Input - Output Impedance	50 ohms (approximately)	
Accuracy of FM Deviation Measurements	4 percent of fullscale in the spectrum of 60 Hz to 4 kHz. Response down 2 db at 20 kHz.	
Signal Generation (20-980 MHz region)		
Frequency Accuracy (Long Term)	0.0001 percent of all frequencies	
Output Level - Calibrated	0.1 to 100 microvolts within 2 db (into 50-ohm load)	
Internal FM	1-kHz (normal) modulating frequency. Deviation continuously variable to 25 kHz. Distortion less than 2 percent.	
External Modulating Signal	60 Hz to 20 kHz	
IF and Audio Generation		
Frequency Ranges	100 Hz to 0.9999 MHz 1-9.999 MHz (on harmonic basis)	

Output level (Variable) - uncalibrated	0-10 MHz: zero to 0.6 volt (approximately) 1-10 MHz: zero to 40 millivolts (approximately)
Power Requirement	117 or 230 vac $\pm$ 10 percent 50-400 Hz, 45 watts
Dimensions	10 - 3/4 in. high 10 - 15/16 in. wide 16 - 1/2 in. deep
Weight	39 lbs. net 45 lbs. shipping

Exhibit 3-C

HOT JOURNAL DETECTOR

Over the past 10 years, a number of railroads have made applications of electronic systems for the purpose of detecting heat in journals of car wheels. These systems have proven useful in detecting overheated bearings before they endanger further movement of the train.

Recently, a new hot box detector system has been introduced to the railroad industry. This new system scans a portion of the arch bar member of the side frame directly behind the hinge pins of the journal lids. This area is viewed from a standard located approximately 4-1/2 ft. from gauge, the viewing angle of the sensor being inclined about 5 deg. from horizontal and at an angle of approximately 45 deg. with the gauge line. The view line being approximately 2 ft. above top of rail will remain unobstructed without attention in many heavy snow areas. The design is intended to provide uniform indications regardless of type of bearing and eliminate some detections due to heat from extraneous sources.

Characteristics.

Speed Range	2 to 95 + mph (Bidirectional).
Ambient Temperature	-40C (-40F) to 54C (130F).
Scanning Mode	Horizontal trace across topmost structural member of truck side frame (arch bar) approximately 25 in. above top of rail.
Scanner Position	Wayside standards placed 54 in. from gauge line.
Track Instruments	Four wheel detectors mounted on outside rail by means of rail clamps.
Power Requirements	Field - 120 Volts, 6 Amps maximum. 28 Volts d-c battery. System is automatically on standby in event of power failure.
Carrier	FM type.
Readout	Two channel graphic recorder (Ink or heat writing).

Peripheral Components	Foundations, all interconnecting cables, alignment bridges are supplied with system.
Equipment Housing	4 ft. by 4 ft. by 7 ft. erected aluminum extruded interlocked channel, wired for thermostatically-controlled heating and ventilating plus lighting and receptacles.
Accessibility	Functional modules on panel assembly. Components accessible without disassembly.
Test Facility	Integrated test oscillator. Self-checking by pulsed heat source in sensors.
Alignment	Optical, periscopic.

General Description.

The system is supplied as a complete hot box detector comprised of the following major components:

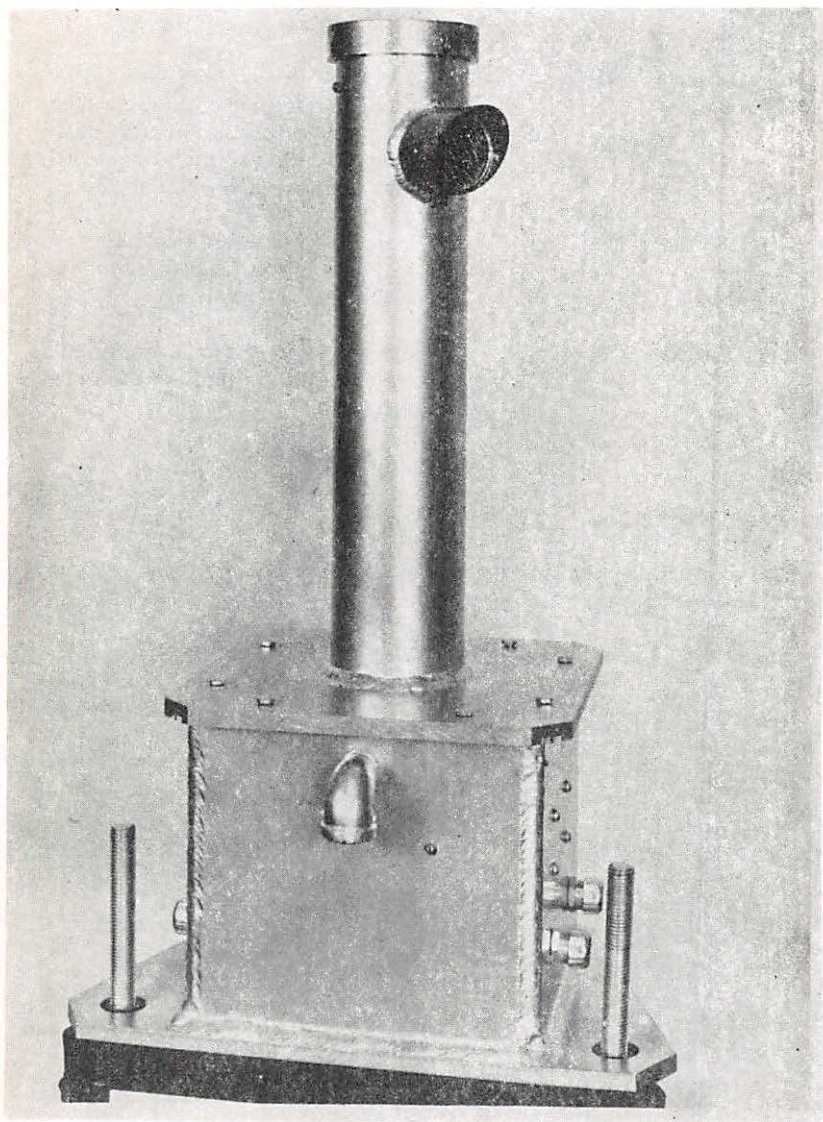
Wayside Equipment

Two infrared sensor standards (Figs. 1 & 2)

Four wheel detector units with rail clamps. (Fig. 2)

One 4 ft. by 4 ft. by 7 ft. aluminum equipment house (Fig. 2) enclosing (Fig. 3):

1. Battery charger panel.
2. Set of batteries.
3. D-C power panel.
4. Gate panel.
5. Two-channel carrier transmitter panel.
6. Approach relay switching panel.
7. Control panel.



Wayside Sensor Standard
Fig. 1

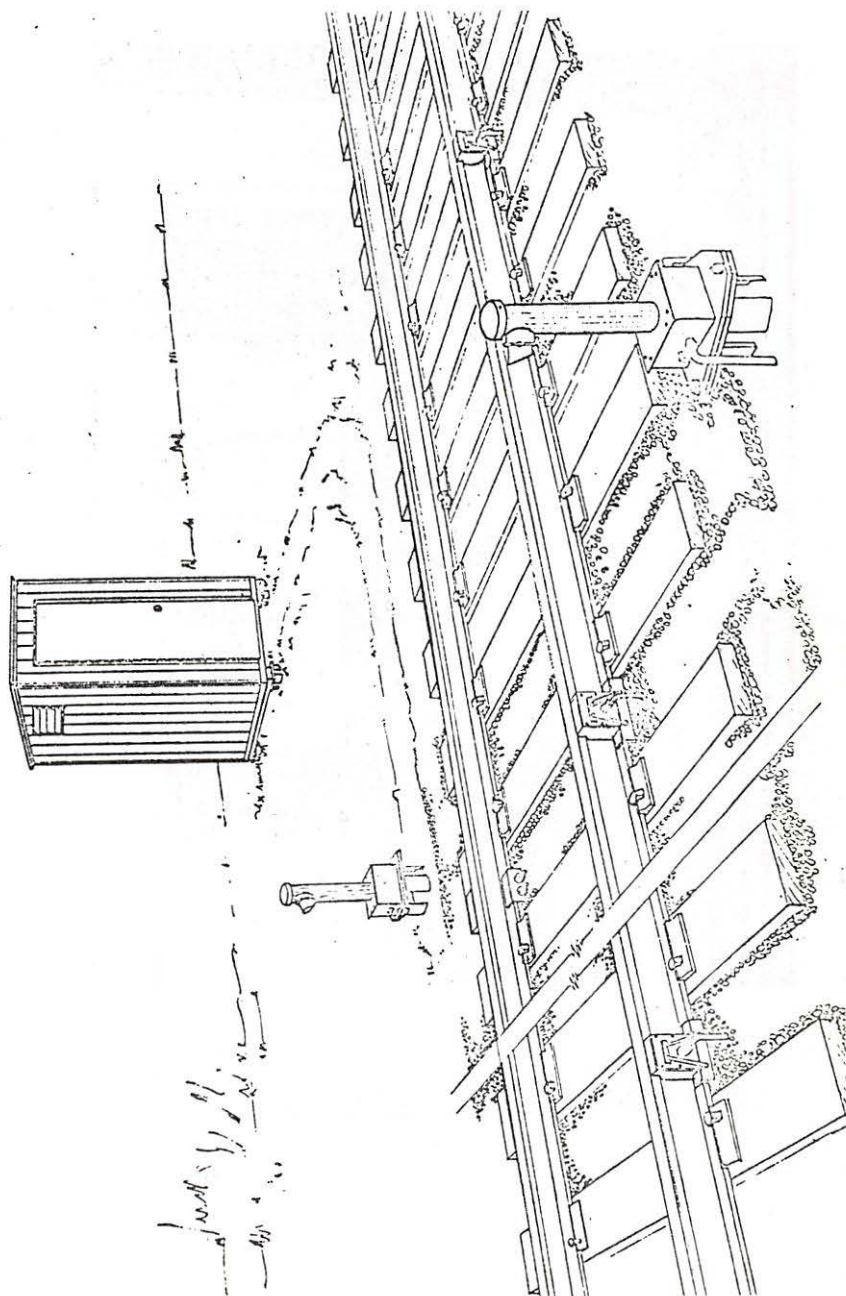


Fig. 2

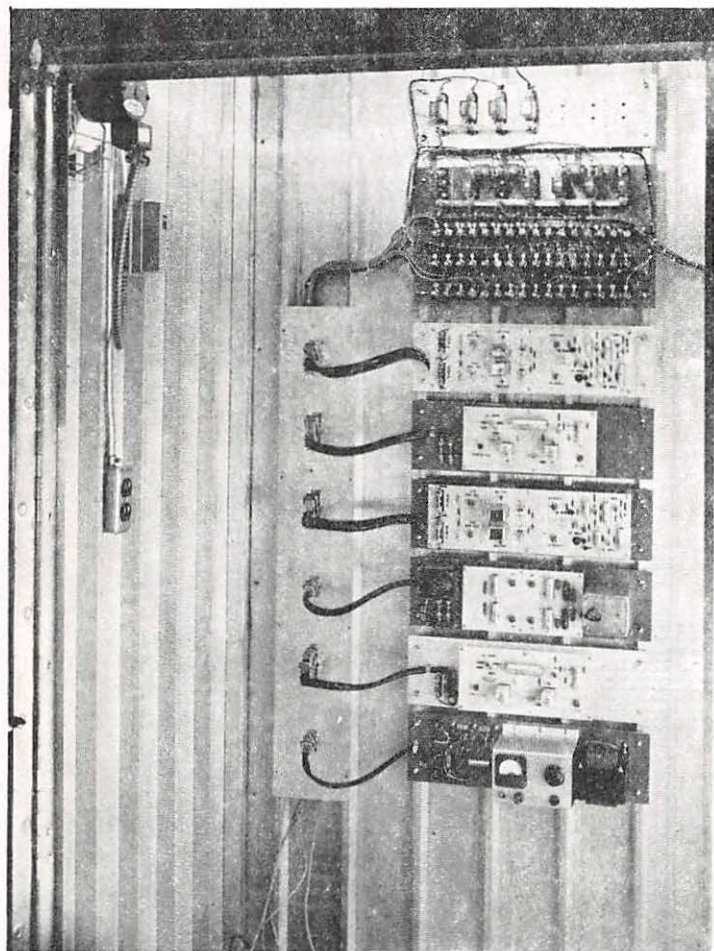


Fig. 3

Office Equipment (Fig. 4):

Attenuator panel.

Carrier receiver panel.

Recorder.

Cabinet will accommodate a
second system.

Operation.

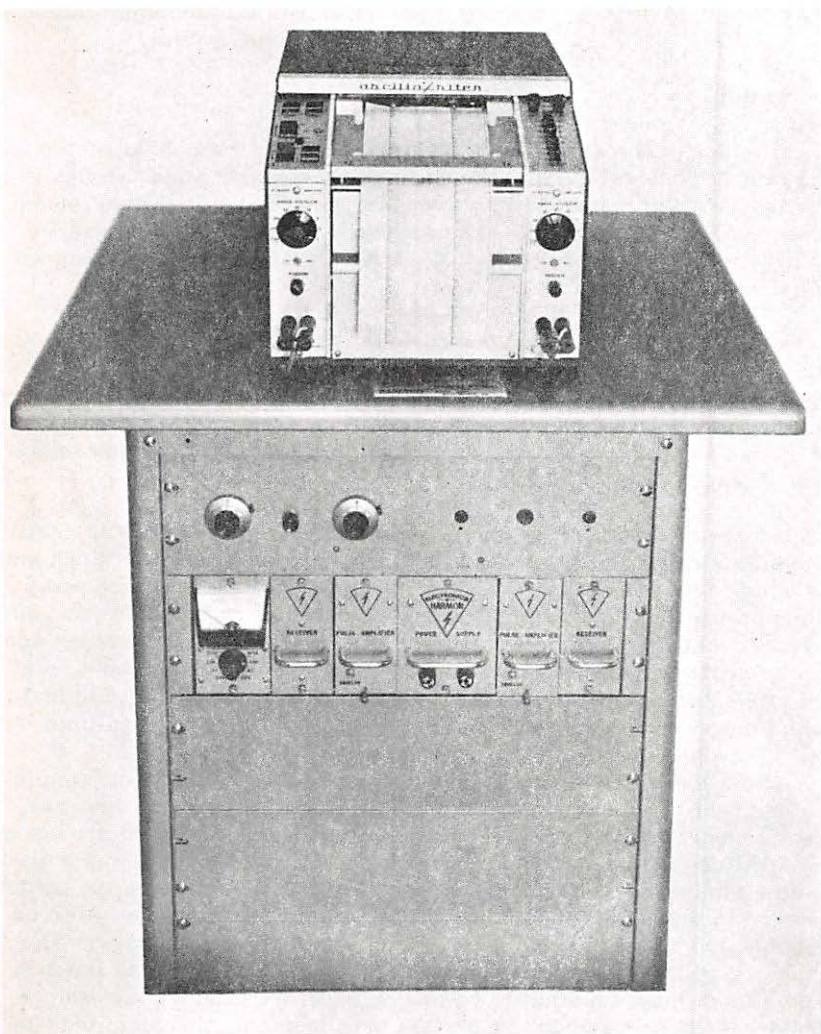
The block diagram, Fig. 5, shows the interrelationship of the major components. Signals from each sensor are gated through to the dual-carrier channels by the events governed by the wheel detectors, NA, NG, RA and RG. The approach relay selects the proper pair of wheel detectors (either NA & NG or RA & RG) depending on the direction of the train.

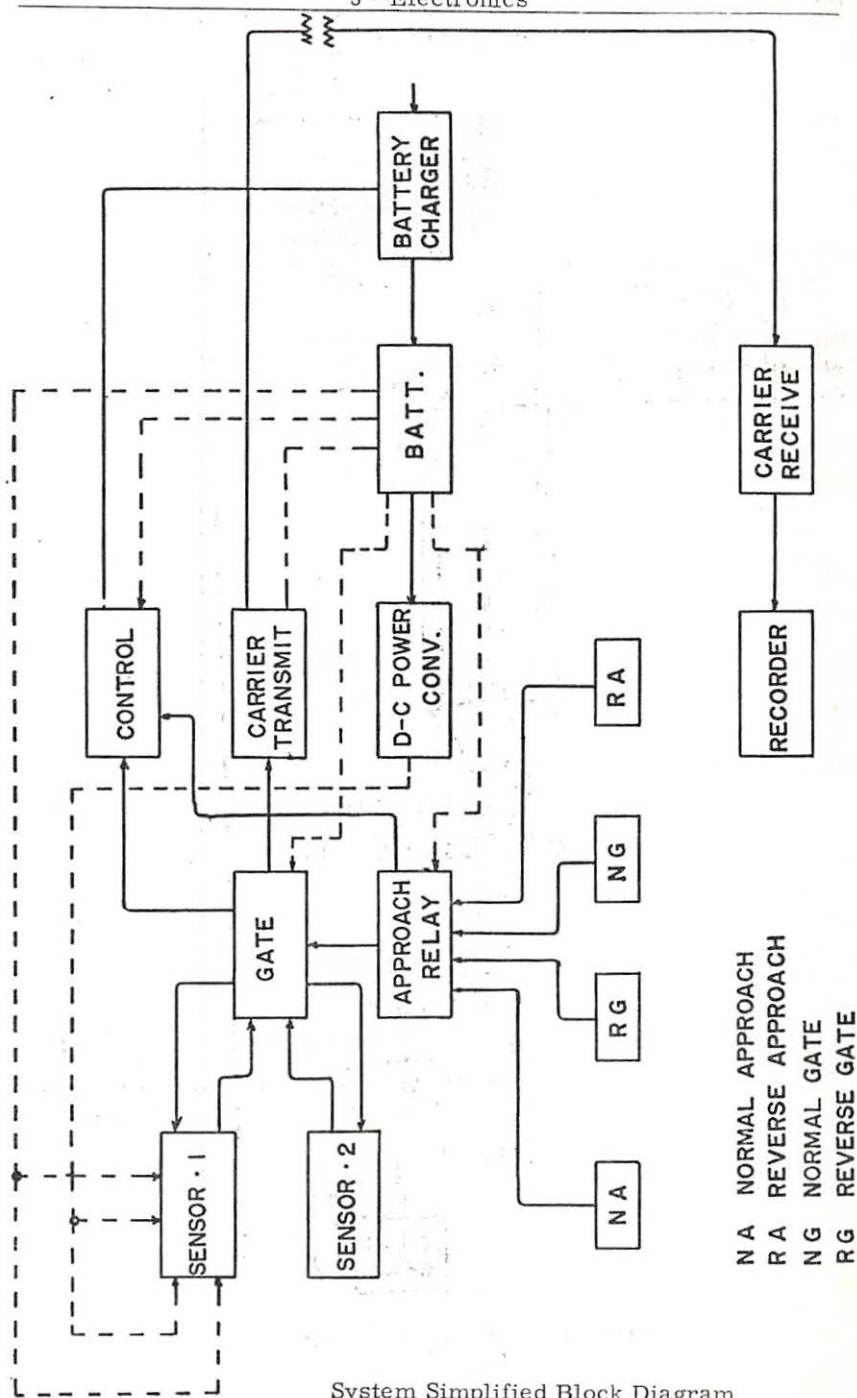
A time delay relay keys the carrier, disconnects sensor heaters, disconnects battery charger, connects gate function and locks out opposing approach circuits. Battery voltage is fed to all panels requiring power and for the heaters in the sensors. A d-c regulator and power converter is used to control the bolometer and preamplifier voltages.

Infrared Sensors (Fig. 6). Two infrared sensors, one for each wayside standard, are identical and may be interchanged. Each unit is composed of a coaxial array of discs which mount the individual components. An insulated sleeve over a number of discs forms an oven to control the temperature range over which the bolometer and preamplifier must operate. The insulated oven permits the use of small heaters (20 watts) so that the power requirement is minimal when the system is operating on battery in a power-off condition.

At the top of the sensor assembly, a small incandescent lamp is pulsed in synchronism with the gating pulse to provide an internal heat source. Infrared energy from this source is fed directly through an aperture of an inclined mirror to the condensing lens and bolometer element. The inclined mirror directs energy from the target source to the same lens and bolometer element. Thus the infrared signals are added. The preamplifier is the differential type. The target plus lamp signal is fed to one input while the second input is taken from the midpoint of two low noise film resistors across the bolometer power supply. With this arrangement, transient noises from the bolometer supply are effectively cancelled in the preamplifier.

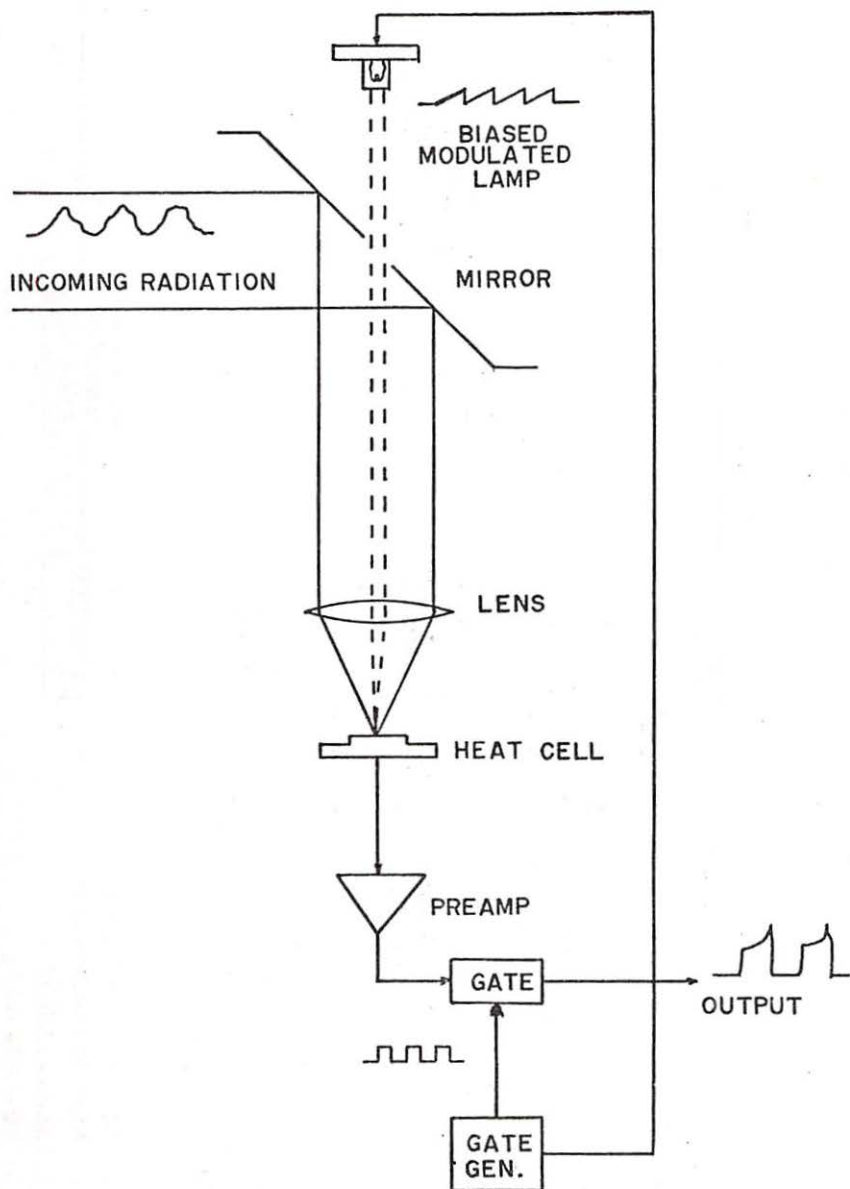
The system may be operated with or without the internal heat source (lamp bulb), but it should be noted that the use of the lamp provides a journal-by-journal check on the integrity of the system in the absence of heat from the passing target.

Office Equipment
Fig. 4



System Simplified Block Diagram

Fig. 5



Generation of Composite Signal
Fig. 6

Wheel Detector. The wheel detector is a transducer which is mounted on the outside of the rail. A total of four are utilized per system. The detector fits the ball of the rail and is clamped to the base, with no drilling required. The magnetic structure and encasement is designed to permit replacement and resealing in the field. Cylindrical bar magnets with like poles facing up cause the magnetic flux to be concentrated in the coil core by repulsion. The passing of the wheel tread creates an a-c single-cycle output.

A wheel passing over either of the entering transducers sets up direction through an approach switching panel for operation of the corresponding gating transducer.

Control Panel. The control panel contains a time delay relay and a unijunction relaxation oscillator for test purposes.

The system has been packaged to simplify the installation and maintenance. Alignment may be quickly accomplished by placing rectangular flag on bridge approximately 2 ft. above rail and adjusting mirror and sensor until flag image appears on center of inner lens.

Exhibit 3-D

LOOP FOR AUDIO FREQUENCY OVERLAY EQUIPMENT

When the use of audio frequency overlay equipment first started, one type of receiver was coupled to the track by means of a pick-up loop.

The main objective of the loop coupling was to provide good shunting definition; that is, rapid pick-up or drop-away of the track relay as soon as the train had passed the loop. This occurred because the signal induced in the loop is dependent on the amount of current flow in the rails. This is at a maximum when the train shunt is immediately adjacent to the loop before entering the track circuit between the loop and the transmitter.

This same result (good shunting definition) has been attained in later design equipment, without the use of loops, by making the source impedance of the transmitter and the terminating impedance of the receiver quite low. An impedance of 1 to 2 ohms is typical. By making the source (transmitter) low impedance, the approaching train does not shunt the track circuit until the effective shunt impedance (train shunt impedance plus series impedance of rail) becomes low, which means short distance. The same effect occurs at the leaving end of the circuit, which means that the signal level at the receiver rises rapidly as the train leaves the circuit.

Therefore, as loops are no longer required for audio frequency overlay equipment application, it is recommended that this assignment be closed.

REPORT OF

COMMITTEE 4--RADIO

- T. M. Evans (Chairman), Comms. Engr., Chicago & North Western Ry.
H. C. Macomber (Vice Chairman), Gen. Supt. Comms., Missouri Pacific R.R.
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July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
4. Keep in touch with any government activities affecting the status of railroads with respect to the application of radio:
 - (a) Cooperate with FCC in assignment of frequencies to individual railroads.
 - (b) Coordination of the assignment of radio frequencies in the United States and Canadian border areas.
5. Assist any railroad to obtain a radio license from the Federal Communications Commission consistent with the policies of the Association of American Railroads.
6. Investigate and report on the use of radio, inductive carrier, or allied communication in connection with railroad operations.
7. Keep in touch with activities and developments in connection with radio services of other organizations.
8. Cooperate with the Sectional Committees of the United States of America Standards Institute (formerly American Standards Association) on the following:
 - (a) Radio, C16.
 - (b) Radio-Electrical Coordination, C63.
12. Prepare instructions covering precautions to be observed in the installation and maintenance of transistorized equipment. This will include special techniques in the handling of transistors under test and general requirements for test equipment.
15. Investigate and report to the Committee of Direction on the radio frequencies for remote control of engines, the number of frequencies and bandwidth required, and also the proper frequency allocation to be considered under this assignment.
17. Investigate and report on the design and application of protective devices for transistorized equipment on diesel engines, and other mobile equipment.
19. Prepare requisites covering use of radio in connection with remotely controlled, cab mounted switching signals for switching engines.
20. Investigate and report on sources and nature of electrical noise affecting radio reception and methods of suppression in mobile equipment.
21. Investigate and report, and if deemed desirable, prepare instructions for maintenance and painting of radio towers.
22. Investigate and report on, and if deemed necessary, prepare specification for, a light density-medium haul microwave system.

23. Investigate and report on, and if deemed necessary, prepare specification for, use of information display devices on engines and cabooses via radio, with consideration given to type of equipment and channels used.

24. Investigate and report on methods of determining the transmission quality of waveguide/antenna installations for microwave applications.

25. Investigate and report on comparative performance of hot standby versus space diversity and crossband frequency diversity in microwave radio operation.

The committee submits for consideration, reports on the following subjects:

1. Communication Manual Part 12-21--Specification Covering Maintenance of Railroad Radio Equipment, revised as shown in Exhibit 4-A, page 114.

Action Recommended

Approval to supersede subject matter in the Communication Manual.

1. Communication Manual Part 12-22--Specification for the Electrical Requirements of Radiotelephone Transmitting and Receiving Equipment on Locomotives, Cabooses, and Other Rolling Stock, revised as shown in Exhibit 4-B, page 122.

Action Recommended

Approval to supersede subject matter in the Communication Manual.

1. Communication Manual Part 2-J-9 and Signal Manual Part 187--Instructions for the Installation and Maintenance of Transistorized Equipment, revised as shown in Exhibit 4-C, page 125.

Action Recommended

Approval to supersede subject matter in the Communication Manual and the Signal Manual.

4. Government Activities Affecting the Status of Railroads With Respect to Radio, as Exhibit 4-D, page 128.

Action Recommended

Acceptance as information.

5. **Assistance to Railroads.** The Committee Officers and the Engineer, Communications and Signals, continued this assistance during the year. It consists of furnishing information by answering questions and by circulars to Member Roads in connection with filing both routine and non-routine applications for FCC authorizations. At times, conferences with FCC Staff members are required.

Action Recommended

Acceptance as information.

6. Circulars pertaining to radio matters issued during the year as follows:

- C&S-166 (May 3, 1966)--Rules Amendments-Station Licensees, Reporting of Changes of Name or Address.
- C&S-172 (June 28, 1966)--FCC--Proposed Rule Making, Docket No. 16259.
- C&S-173 (July 29, 1966)--FCC--Notice of Proposed Rule Making, to Provide for the Use of Radio for Unattended "Talking Hot Box Detectors," etc.
- C&S-174 (August 1, 1966)--FCC--Notices of Proposed Rule Making, Docket Nos. 16776 and 16777.
- C&S-175 (August 1, 1966)--FCC--Notice of Proposed Rule Making, Docket No. 16779.
- C&S-177 (August 3, 1966)--FCC--Report and Order in Docket No. 16218.
- C&S-184 (November 28, 1966)--FCC--Notice of Inquiry, Docket No. 16979.
- C&S-187 (December 12, 1966)--FCC--First Report and Order, Docket No. 13847.
- C&S-188 (December 14, 1966)--FCC--Notice of Inquiry, Docket No. 16979.
- C&S-189 (December 20, 1966)--FCC--Report and Order, Docket No. 16385.
- C&S-190 (December 20, 1966)--FCC--Report and Order, Docket No. 16780.
- C&S-191 (January 3, 1967)--Frequency Assignment Plan--January 1967.
- C&S-194 (February 11, 1967)--FCC - OEP Orders-Priorities--Restoration of Leased Intercity Private Line Services During Emergency Conditions.
- C&S-196 (February 20, 1967)--FCC--Report and Order, Docket No. 16591.
- C&S-197 (March 1, 1967)--FCC--Notice of Proposed Rule Making, Docket No. 17228.
- C&S-198 (March 14, 1967)--FCC--Supplementary Notice of Inquiry, Docket No. 16979.
- C&S-200 (March 28, 1967)--FCC--Interconnection Case-Private Microwave to Common Carrier.

C&S-202 (March 29, 1967)--FCC--Memorandum Opinion and Order in Docket No. 16218, Expanded Cooperative Use of Operation Fixed Stations.

Action Recommended

Acceptance as information.

6. Statistics on Railroad Radio Authorizations, Inductive Carrier Installations and Microwave Point-to-Point Systems, as Exhibit 4-E, page 132.

Action Recommended

Acceptance as information.

20. Interim Report on Sources and Nature of Electrical Noise Affecting Radio Reception and Methods of Suppression in Automotive Equipment, as Exhibit 4-F, page 139.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 4--RADIO

Exhibit 4-A

(Revised Communication Manual Part 12-21)

MAINTENANCE OF RAILROAD RADIO EQUIPMENT

A--Purpose

A-1. The purpose of this manual part is to provide information relative to establishing facilities and procedures for maintenance of railroad radio equipment.

B--Drawings and Specifications

B-1. Drawing included:

Fig. 1--Typical Floor Plan for Radio Service Shop.

B-2. Specification referred to:

Manual Part 12-11--Kind and Amount of Equipment Desirable for the Maintenance of Railroad Radio Transmitters, Receivers and Associated Equipment.

C--General

C-1. **Maintenance Requirements.** Radio equipment utilized in the railroad radio service is relatively complex. Both the frequency range in which it is operated and the low signal strength at which operation is frequently required (0.25-1.0 microvolts per meter) contribute to the need for good maintenance.

C-2. **Maintenance Systems.** Two general classes of radio maintenance systems have been employed in the railroad service--centralized and decentralized.

C-3. **Centralized System.** In the centralized system, a limited number of service shops are established which are centrally located with respect to the area served by the railroad. Defective radio units as well as those due for periodic maintenance are shipped to the service shop by company baggage or other appropriate means.

C-4. **Decentralized System.** In the decentralized system, very little shipping of equipment is necessary. Service shops are established at a sufficient number of points so that all, or nearly all, road engines and cabooses will be in the vicinity of such a point at relatively frequent intervals. Isolated base stations and mobile units may be serviced by means of an automobile operating from a conveniently-located service station.

C-5. Selection of the System. The type system selected by an individual railroad will depend on several factors as follows:

(a) The size of the radio system and the geographical distribution of both base stations and mobile units. If the initial radio installation is reasonably well concentrated, a centralized system with one service station should suffice. Later, as the radio system is expanded, the servicing system can be enlarged on either the centralized or decentralized basis.

(b) A considerable amount of test equipment and tools are necessary to properly service railroad radio equipment. Such equipment is available in various grades, degrees of accuracy, etc., and generally, the best equipment is quite costly. Obviously one, or a few, centralized service shops can be better equipped at a lower overall cost than a decentralized system of several shops.

(c) Concentration of all servicing in a few shops may reduce the total number of radio maintenance men required.

(d) Concentration of all servicing in a few shops may result in maintenance men becoming more proficient in their duties, particularly in the diagnosis and correction of equipment faults.

(e) Where the radio system includes main line installations in critical areas and important yard and terminal installations, it may be that the advantage of having radio maintainers readily available will dictate decentralized maintenance.

(f) With a centralized system, the outage time of a particular radio unit will be increased by the time taken in transit to and from the point of use. This might require investment in a larger number of spare units or might result in an increase in base and mobile installation outage time.

(g) When radio units are shipped frequently or over relatively long distances, the probability of damage or misadjustments occurring in transit is increased.

C-6. Location of Service Shops. Regardless of whether a centralized or decentralized maintenance system is established, there are certain factors to be considered in selecting the location of maintenance shops.

(a) In a centralized system, a location as close as possible to the operating center of the area equipped with radio is advisable, since distance over which equipment must be shipped and the time in transit will both be reduced.

(b) If the railroad mileage is under approximately 1000 miles and operating headquarters are maintained at or near one end, it may be advisable to locate the service shop in the headquarters area.

(c) In a decentralized system, service shops may be located in terminal areas where two or more operating divisions terminate. Such a location will be readily accessible for servicing mobile units operating on such divisions.

(d) In both the centralized and decentralized systems, it is advisable to locate service shops at points where general maintenance facilities are readily available.

C-7. Type of Service Shops. Each service shop should provide adequate space for a large work bench, desk, file cabinet, storage shelves for spare units, and storage shelves or cabinet for spare parts, including electron tubes. Good lighting should be provided and so located to eliminate shadows over the work bench. Air conditioning or adequate ventilation of the shop, including exhaust fans and air intake filters to exclude dust, should be provided. Proper insulation of floor and benches should be provided to prevent possible electrical shock hazards. A typical floor plan for a service shop is shown in Fig. 1.

The service shop work bench should be approximately 30 in. wide, 30 to 42 in. above the floor and of sufficient length to provide 6 ft. of space for each service position. It is desirable to provide a shelf at approximately 18 in. above the work bench. Test equipment mounted on this shelf will be conveniently located for use, yet the bench will be left clear for equipment being serviced. A similar shelf located between the bench and the floor will provide a convenient location for any special power equipment required. Cabinets above and below the bench may also be used.

In addition to a number of conveniently-located regulated 117-volt a-c bench outlets, 6, 12, 32, 64 or 120, or other voltage regulated d-c power supplies as may be necessary for testing any radio equipment to be serviced, should be provided.

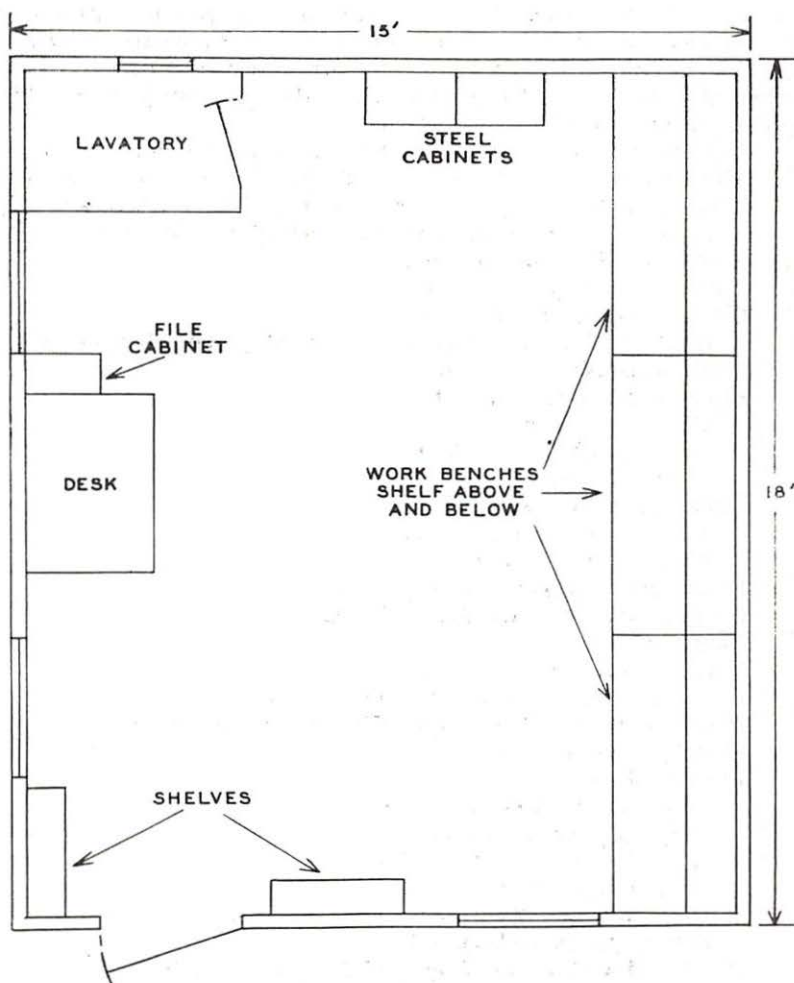
A source of compressed air, preferably dried, is desirable for cleaning equipment.

D--Personnel

D-1. Qualifications. Each railroad radio serviceman may often be required to make his own analysis of equipment faults in a limited time and take effective measures to correct them. It is therefore important that such men have had practical experience in service and repair of mobile-type radiotelephone transmitters, receivers and associated equipment and accessories. The rules of the Federal Communications Commission require that all transmitter adjustments which may affect the proper operation of the radio station must be made by, or under the immediate supervision of, a person holding a first or second class operator license, either radiotelephone or radiotelegraph.

E--Equipment, Tools and Supplies

E-1. Test equipment for servicing railroad radio equipment is



Typical Floor Plan for Radio Service Shop
Fig. 1

listed, and some data on its use given, in Communication Manual Part 12-11--Kind and Amount of Equipment Desirable for the Maintenance of Railroad Radio Transmitters, Receivers and Associated Equipment.

E-2. Tools. The following tools are suggested for an average service shop. In some cases, the item listed may not be required in servicing the type of equipment used by the railroad. The number of tools required will be determined by the number of servicemen on duty at one time.

Alignment tools--appropriate for equipment used.

Allen wrenches--to 1/4 in. and for Nos. 2 to 8 capscrew.

Cabinets, drawer type, appropriate size for storage of spare capacitors, resistors and miscellaneous small parts.

Chisel, cold, about 7 in.

Contact burnisher.

Drill, electric, 1/4 in.

Drill bits, straight shank, high speed, sizes as required.

Drill, automatic push.

Files, hand, flat.

12 in., cut 1 or 2.

8 in., cut 3 or 4.

4 in., cut 6.

Files, round

4 in. medium cut.

6 in. medium cut.

Flashlight, rubber enclosed.

Hacksaw and spare blades.

Hammer, claw.

Mirror, inspection.

Pin straighteners, 7-pin and 9-pin.

Plastic clear spray, Krylon or approved equivalent.

Plastic tape.

Pliers.

Combination, 5 in.

Diagonal cutters, 5 in.

Long flat nose, 5 in.

Long nose, 5 in.

Plier-wrench, snap-lock, 7 in.

Side cutting, 8 1/2 in.

Punch, center, about 3/8 in. by 5 1/2 in.

Screw drivers:

Standard type in several sizes.

Phillips type in several sizes.

Offset, one standard and one Phillips.

Screw holding type.

Socket wrench set (or hex nut driver set).

Soldering aid.

Soldering irons, electric.
Heavy duty.
Light duty.
Desoldering tool.
Unsoldering attachments for printed circuit boards.
Solder, rosin core.
Special tools and jigs.
Tap and Die Set, appropriate sizes.
Tube puller.
Vise, bench.
Wrench, adjustable.

E-3. **Supplies and Spare Parts.** The following supplies are suggested for each service shop. If a large number of radio units are in service, it will be found more economical to provide a large quantity of spare parts at only one or two central points with distribution from these points to service shops as required.

Batteries, dry, appropriate for replacements.
Capacitors--mica, ceramic, paper and electrolytic; of appropriate values for replacements.
Crystals.
Electron tubes--replacements for each type used in the equipment serviced.
Miscellaneous components.
Miscellaneous radio hardware.
Resistors--wattage rating, resistance value and tolerance appropriate as replacements.
Set screws, appropriate sizes.
Transistors and other semiconductors--replacements for each type used in equipment serviced.
Wire, hookup.

F--Governmental Requirements

F-1. The rules of the Federal Communications Commission (FCC), Part 93--Land Transportation Radio Services (which includes the Railroad Radio Service) require that measurements be made of the frequency, plate power input to the final radio stage and modulation of authorized transmitters, except final input power measurements are not required for mobile units. Details concerning these measurement requirements will be found in section 93.108 of Part 93. They are also discussed in Communication Manual Part 12-11.

F-2. The rules of the FCC also require that records of the above measurements must be maintained. Records must also be maintained of any service or maintenance performed which may affect the proper operation of the station. Details concerning these records will be found in section 93.160 of Part 93.

F-3. In Canada, railroad radio equipment must be type approved. The Department of Transport requires that adequate

maintenance will be carried out by the licensee to ensure that at no time during the life of the type approved equipment will its performance fall below the minimum standards prescribed by the relevant Radio Standards Specification.

G--Maintenance Schedules

G-1. The radio equipment should be scheduled for preventive maintenance at regular intervals, not to exceed 6 months.

G-2. Some railroads have adopted a policy of allowing equipment to remain in service until failure occurs and report that the results are satisfactory.

G-3. The maintenance schedule selected by a railroad will depend on many factors, including:

(a) If the radio communication system is such that the maximum range of the system must be utilized, it would be necessary that radio equipment be maintained at its peak-performance level. Such a requirement would dictate servicing at frequent intervals.

(b) The removal of units from service and transportation to a service shop may in itself result in failure of equipment due to rough handling.

(c) Generally, optimum test meter readings of equipment at specified test points will indicate when tube testing is required.

(d) Replacement of electron tubes solely on a basis of hours of service is not considered good practice. Tubes are more likely to fail in the first 50 hrs. of service.

H--Maintenance Procedures

H-1. All manufacturers of standard railroad radio equipment provide Instruction Books which include detailed instructions for maintenance of their equipment. The following recommendations are therefore generalizations covering all makes of equipment:

(a) **Cleaning.** When equipment is bench-serviced, the first step should consist of a thorough cleaning of equipment. Dust and loose dirt may be blown out of the set by compressed air, or removed by vacuum.

(b) **Visual Inspection.** The equipment should be inspected for loose or corroded connections, frayed handset cords, discolored resistors and damaged capacitors. The last two defects are indications of overloading of these components and therefore, if found, will indicate the necessity of voltage and resistance tests to determine the cause of the overload.

(c) **Normal Performance Criteria.** It is advisable to establish normal performance criteria including test point readings for the type of equipment used. This may be determined from manufacturers' data or by tests on several sets when new. Thus, if the equipment being serviced has not actually failed in service,

and visual inspection reveals no defects, the serviceability of a unit may be established by a determination that the transmitter power output and the receiver sensitivity and test point readings are within permissible limits of the performance criteria.

J--Records

J-1. In addition to the records required by FCC (see paragraph F-2), it is desirable that additional records be maintained. Such records might consist of the following:

(a) **Location Record.** A card record for each unit of equipment showing:

1. Where stored, if not in service.

2. Engine, caboose or other vehicle number of base station, if in service.

(b) **Service Record.** A card record of all service performed on each unit.

(c) **Transmitter Measurements Record.** Although records of measurements will normally be entered on the service record, it may be found desirable to maintain a separate record of transmitter measurements required by FCC.

(d) **Failure Report.** A record maintained on a periodical basis, such as monthly, on which the total number of failures are summarized. This record will show weak spots in equipment, in servicing procedures or in use of equipment, and after a period of time, will indicate measures to be taken which might improve the reliability of the system.

J-2. Pack type transmitters or complete transmit-receive units of the pack type may require different treatment in the matter of records. For example, if such units are used on trains, some form of "charge-out" record may be required. Records of power supply batteries may also be required.

J-3. As the number of radio units which a railroad has in service increases, the recording job may become burdensome. It is therefore advisable in setting up a record system, to be certain that each item recorded is required by law or regulation or the accumulation of data thereon will contribute to the development of reliability, efficiency and economy of the radio communication system.

Exhibit 4-B

(Revised Communication Manual Part 12-22)

SPECIFICATION FOR THE ELECTRICAL REQUIREMENTS
OF RADIOTELEPHONE TRANSMITTING AND RECEIVING
EQUIPMENT ON ENGINES, CABOOSSES
AND ROLLING STOCK

A--Purpose

A-1. The purpose of this specification is to guide the manufacturer in the supplying of power plants for radiotelephone transmitting and receiving equipment on rolling stock.

B--Drawings and Specifications

B-1. Drawings--None included.

B-2. Specification referred to:

Manual Part 12-10--Requirement Specification for Frequency Modulated Radiotelephone Transmitting and Receiving Equipment.

C--General

C-1. Radiotelephone transmitting and receiving equipment meeting AAR specifications are commercially available to operate from the following electrical power sources:

- (a) 117 volts, 60 Hz alternating current.
- (b) 13.6 volts direct current.
- (c) 72 volts direct current.

C-2. Duty Cycle. The duty cycle of radiotelephone transmitting equipment, under normal operating conditions, will usually not exceed 5 minutes on and 15 minutes off for a period of 7 hrs.; and 10 seconds on and 20 seconds off for 1 hr. The receiving equipment shall operate continuously. Occasionally, however, circumstances may occur where continuous primary power under transmitting conditions is required.

C-3. Normal Service Conditions. The normal service conditions of such equipment are any combination of the following:

- (a) Ambient Temperature..... -30 C (-22F) to 65 C (150F).
- (b) Ambient Humidity..... 0 to 95 percent.
- (c) Duty..... As specified in paragraph C-2.
- (d) Line Voltage..... 117 volts a-c, 60 Hz, single phase; or 13.6 volts d-c; or 72 volts d-c.

**D--Electrical Requirements for Alternating Current
Radiotelephone Transmitting and Receiving Equipment**

D-1. Regulation. The voltage and frequency of the 117-volt a-c power source shall not deviate by more than 5 percent under rated load and no-load conditions.

D-2. Primary Power Requirements. The alternating current power required by such radiotelephone transmitting and receiving equipment varies according to the number of receivers and transmitters employed and the rated power output of the transmitter(s). The power requirements for a radio will vary from 15 watts under standby conditions to a maximum of 300 watts while transmitting.

D-3. Deviation Factor. The deviation factor* of alternating current power source voltage wave shall not exceed 0.1.

D-4. Power Factor. The power factor presented by this equipment to the 117-volt a-c electrical power source shall be greater than 0.9.

**E--Electrical Requirements for Direct Current
Radiotelephone Transmitting and Receiving Equipment**

E-1. Regulation. The direct current voltage at the power input terminals of radiotelephone equipment shall not deviate more than the following, under rated no-load and maximum load conditions:

Rated Input Voltage	Maximum Input Voltage	Minimum Input Voltage
13.6	15.5	10.9
72	85	58

* The deviation factor of a wave is the ratio of the maximum difference between corresponding ordinates of the wave and of the equivalent sine wave to the maximum ordinate of the equivalent sine wave when the waves are superposed in such a way as to make this maximum difference as small as possible.

E-2. Current Requirements. The direct current required by radiotelephone transmitting and receiving equipment, for various rated input voltages, varies according to the number of receivers and transmitters employed and the rated power output of the transmitter(s). For a single receiver and one 10 to 30-watt transmitter, typical current requirements are:

Rated Input Voltage	Minimum Standby Tube	Current, amps Solid State	Maximum Transmit Tube	Current, amps Solid State
13.6	9	0.1	30	15
72	1.5	0.1	4	4

Exhibit 4-C

(Revised Communication Manual Part 2-J-9
and Signal Manual Part 187)

**INSTRUCTIONS FOR THE INSTALLATION AND
MAINTENANCE OF SOLID STATE EQUIPMENT**

A--Purpose

A-1. These instructions apply to the installation, maintenance and tests of solid state equipment, and are also intended as a guide to minimize accidental damage to and failure of transistors and other semiconductors.

B--General

B-1. **Installation Precautions.** High ambient temperature locations, above 49 C (120F), must be avoided unless equipment is specifically designed for such temperatures. This includes locations near other devices that radiate considerable heat, such as radiators, tube type electronic equipment, steam lines, etc. Consideration must also be given to avoiding low ambient temperature locations, below -24 C (-10F), for transistorized equipment not specifically designed to operate at such temperatures. It may be desirable to add a small source of heat at low temperatures to overcome frost problems, etc.

Where radiant energy is the heat source, it is recommended that a metallic baffle be inserted between such source and the transistorized equipment. Installation of equipment in small enclosures should be avoided unless special tests are made to insure that the ambient temperature within such enclosure with the equipment in operation does not exceed 49 C (120F).

Many types of transistorized equipment may require special mounting as specified by manufacturer.

Check wiring and test for proper polarity before connecting solid state equipment.

Surge voltage protection must be provided on: d-c power sources, a-c power lines, and communication lines connected to solid state equipment. The type of protection will be governed by the normal voltage on the line, inductive exposure, location area and economic considerations. Surges and transients may consist of high and/or low-frequency components. Engine battery supplies must be provided with a spike filter because of the large number of sources of transient voltages encountered.

B-2. Circuit Testing. Unlike vacuum tube equipment, it is advisable that with transistorized equipment all possible circuit tests (performance, use of an in-circuit transistor checker, resistance, voltage) be made in order to identify the defective circuit before disconnecting any transistors or other circuit components.

A variable power supply will speed detection of defective transistors in some cases. Use with care to prevent applying excessive voltages. Power supplies should be well filtered. Unfiltered supplies apply peak voltages higher than measured voltages.

B-3. Testing Transistors. Damage to transistors by test equipment or testing procedures is usually the result of applying excessive test voltages or excessive heat on the leads when removing from the circuit for testing.

(a) Excessive voltage can result from:

1. Multimeters with ohmmeter scales that apply excessive voltage or result in excessive current when used to test for shorts or opens. Multimeters recommended shall have a sensitivity of at least 20,000 ohms per volt and shall not have more than 1.5 volts open circuit and a maximum of 2 milliamperes short circuit current. In general, multimeters will meet this requirement when restricted to either the $R \times 100$ or $R \times 1000$ ranges. It should be noted that in testing transistors, polarity of meter leads on multimeters must be checked if not already known, as not all multimeters have positive battery on the red test lead.

2. Leakage of line current through an electric soldering iron, or a-c operated test equipment. It is therefore recommended that an isolation transformer be used with all such devices in order to prevent all sources of possible leakage or accidental grounding of portions of the circuit.

3. Never open a circuit or its associated load without first disconnecting the power, unless the equipment is specifically designed to be open-circuited under load. If necessary to test the circuit with its normal load disconnected, an equivalent dummy load must be inserted before applying power. Plug-in transistors or other components must not be removed from circuits when the power is on. Transients thus produced may damage transistors in the circuit.

4. Be careful in making voltage tests on chassis or circuit boards that the probe does not accidentally bridge to an adjacent circuit and introduce a wrong voltage into a transistor circuit. Destruction of the transistor can be instantaneous and without visual indication.

5. Be careful in making out-of-circuit transistor checks to correctly identify leads both in testing and reconnecting.

(b) Causes of excessive heat:

1. Soldering or unsoldering of transistors can result in excessive heat transmitted through the leads, thus damaging

the transistor. Use long-nose pliers or other suitable device to act as a heat sink on any lead to which heat is applied. Use a soldering iron of sufficient wattage (35 to 100 watts) to insure that solder will be melted quickly to avoid prolonged contact. Be sure that surfaces are well-tinned so that the soldering can be accomplished quickly.

2. If the objective is to unsolder the transistor to isolate it for testing, one lead may remain connected. It is preferable to unsolder a component, such as a resistor or capacitor, to open the circuit if convenient, thus keeping the heat away from the transistor. Desoldering irons are also an aid where a number of connections on a rigid device must be unsoldered.

B-4. Replacing Transistors. In replacing transistors that are held in place by a stud and nut, care must be taken that the nut is not tightened excessively, as this can damage a transistor electrically. If the transistor was originally insulated from the chassis, a check must be made after replacement to be sure that this insulation is maintained. Whenever silicone grease was used, it should be replaced, excess grease removed and extreme care exercised to avoid pick-up of any foreign material, such as metallic filings, etc., which may result in either immediate or subsequent damage to the insulation. Such material may also cause distortion of the transistor case, resulting in premature failure of the transistor. Dropping transistors or the bending of leads on the larger flange-mounted type may cause failure.

Replacement of transistors shall be made with (a) exact same number and letter; (b) equipment manufacturer's recommended replacement; or (c) replacement otherwise authorized.

Field effect and certain switching transistors possess extremely high input impedance and, therefore, can be damaged by stray electrostatic, RF and magnetic fields. In shipping and storage, these transistors are wrapped in metal foil and have their leads connected together by suitable means. It is sometimes necessary to maintain the leads connected together by some means even while installing. Gun type soldering irons should not be used.

B-5. Megger Tests. Radio on engines should have provision for disconnection when megger or other high-voltage tests are made on the engine wiring.

B-6. For further reference, consult U. S. Navy Publication entitled "Electronics Installation and Maintenance Book," NAVSHIPS 0967000-0120, available from the Superintendent of Documents, U. S. Government Printing Office, Washington, D. C. 20402.

Exhibit 4-D

GOVERNMENT ACTIVITIES AFFECTING THE STATUS OF
RAILROADS WITH RESPECT TO RADIO

1. Frequency Assignments.

An up-dated copy of the Frequency Assignment Plan was filed with the Federal Communications Commission in January 1967. Since the last report, May 1966, 92 recommendations have been filed with the FCC, involving 412 modifications of the FAP. Subcommittee 4-D continues to handle coordination of frequency assignments in the U.S. - Canadian border area, and 16 of the 95 recommendations included frequencies for use in that area.

2. Fixed (Microwave) Service (FCC Dockets).

Docket 14179. This docket, which involves assignment of Microwave frequencies on a non-interference basis, continues in an inactive status.

Docket 15130. This docket, which constituted a Notice of Inquiry with respect to microwave equipment parameters, continues in an inactive status.

Docket 16218. A Report and Order was released by the Commission on July 15, 1966, adopting the original proposal to permit expanded cooperative sharing of Operational Fixed station facilities to become effective August 22, 1966. Petitions for reconsideration and suspension of effective date were filed by AT&T and Western Union. The petition for suspension was denied immediately and the reconsideration was denied by a Memorandum Opinion and Order released March 22, 1967.

Docket 16406. This docket was closed on June 14, 1966 without action by FCC, on the basis that any reallocation of microwave frequencies in Hawaii was unnecessary since waivers of the rules can be on a case by case basis when such waivers are proven necessary to care for unique situations.

Docket 16591. A Report and Order was released by the Commission on February 15, 1967, requiring prior coordination with the U.S. Department of Agriculture, U.S. Forest Services of the Bureau of Land Management, U.S. Department of Interior, whenever it is proposed to make application to the FCC for the authority to install or modify any radio transmitting facilities located or to be located on certain lands under jurisdiction of those departments.

3. Mobile Services and Miscellaneous (FCC Dockets).

Docket 13847. By a First Report and Order, the FCC amended Part 93 of its rules, Land Transportation Radio Services, to specify new technical standards applicable to radio stations utilizing frequencies in the 450-470 MHz band. The new technical standards include new specifications of required frequency stability and reduction in authorized bandwidth and maximum permissible frequency deviation of frequency (or phase) modulated transmitters. Specified effective dates of the new standards are in part June 1, 1967 and in part November 1, 1967, with certain exceptions until November 1, 1971. By a later action, the FCC extended the date on which existing systems must reduce transmitter deviation until a further order dependent on further action in this docket.

Docket 15398. This Notice of Inquiry, issued March 27, 1964, relates to the optimum frequency spacing between assignable frequencies in the Land Mobile Radio Services and the feasibility of sharing between the television and the Land Mobile Radio Services. No final decision has been announced by the FCC.

Docket 16259. Final action of this docket was deferred by the FCC June 15, 1966 pending completion of the work of the Advisory Committee for the Land Mobile Radio Services and submission of its report on frequency sharing to the Commission. This report is scheduled to be filed with the FCC in late September 1967.

Docket 16385. A Report and Order was released by the Commission on December 9, 1966, amending various parts of FCC Rules to require evidence of frequency coordination with certain applications involving new stations or modification of existing facilities, to become effective December 7, 1966. The amendments do not affect the current procedure within the Railroad Radio Service in that "advanced" coordination will have been accomplished by means of the AAR Frequency Assignment Plan.

Docket 16474. A Notice of Proposed Rule Making relating to the construction, marking and lighting of antenna towers was released February 1966 and an extended comment period to July 5, 1966 was granted. Final action on the docket has not yet been taken.

Docket 16779. A Notice of Proposed Rule Making, released July 22, 1966 by the FCC, proposes to amend its rules to waive existing requirement for radio station construction permits in all Safety and Special Radio Services. Comments supporting this proposal were filed on behalf of the AAR by the AAR Counsel. Final action by the FCC has not been announced.

Docket 16780. A Report and Order adopted December 7, 1966 and released December 9, 1966, amended its rules governing the

Railroad Radio Service to provide for licensing on a regular basis, of unattended radio stations to transmit information from right-of-way safety inspection devices by means of voice, tone or impulse transmissions. The amendment was effective December 16, 1966.

Docket 16979. By a Notice of Inquiry, dated November 9, 1966, and a Supplementary Notice of Inquiry, dated March 1, 1967, the FCC invited comments on a number of specific items detailed in the Notices, on the subject of the Interdependence of Computer and Communication Services and Facilities. The specified terminal date for the receipt of such comments is October 2, 1967, and a response on behalf of the AAR is being prepared and submitted by Committee 4 through the AAR Washington attorney.

4. FCC-OEP Orders-Priorities.

By concurrent orders on January 17, 1967, the Federal Communications Commission and the Director of Telecommunications Management, Office of Emergency Planning, issued new regulations to govern the priority system to be applied in use and restoration of leased intercity private line services during emergency conditions. The orders became effective July 15, 1967 and were distributed to our Member Roads under Circulars C&S-194 and C&S-206.

5. Petitions for Rule Making.

RM-1068. On November 21, 1966, the AAR through its attorney and at the request of Committee 4, filed a petition with the FCC requesting the allocation of five discrete frequencies in the 72-76 MHz band to the Railroad Radio Service for the specific purpose of providing for remote control by radio of railroad switching engines or cab signals in such engines by portable low-power radio transmitters carried by railroad yard personnel. No action has as yet been taken on this petition.

RM-1101. On January 23, 1967, the AAR through its attorney and at the request of Committee 4, filed a petition with the FCC requesting the allocation of two "band edge" frequencies to the Railroad Radio Service for use on a nationwide basis for the specific application of remote control by radio of "helper" or "slave" engines in main line operations. These frequencies would become available by combining two "splinter" frequencies now allocated to the Land Transportation Radio Services, one "splinter" frequency now allocated to the Public Safety Radio Services, and a "splinter" to be taken from frequencies now allocated to the Maritime Radio Services. No action has as yet been taken on this petition.

6. Other Actions Before the FCC.

AT&T Tariff No. 260, Private Line Telegraph Grade Services.

In response to a request by a number of railroads and on instructions from the AAR General Committee, AAR attorneys on July 18, 1967 filed a petition with the FCC requesting suspension and investigation of certain charges contained in the January 9, 1967 tariff revision (transmittal No. 9467) of the American Telephone & Telegraph Company. In general, objection was made to (1) increased line charges for private line telegraph service and (2) increased equipment rental charges in connection with private line telegraph service.

Docket 17457. Telpak Tariff Sharing Provisions of AT&T and Western Union.

In the interest of possible protection of existing Telpak sharing provisions, under which railroads may currently share Telpak circuits and facilities, the AAR attorney filed a Petition for Leave to Intervene, in the above matter on June 19, 1967. This petition was granted by the FCC Hearing Examiner, with written testimony by AT&T and Western Union to be distributed by August 21, 1967. The date for the formal hearing in this matter has not been set.

7. Advisory Committee for the Land Mobile Radio Services.

The life of this committee has been extended by the FCC from time to time, with the latest extension to September 22, 1967. The final report of the committee is currently nearing completion, with September 6, 1967 as the scheduled date for the last meeting of its Executive Committee to review and approve that report.

8. Operational Fixed Microwave Council.

A separate but subordinate legal entity, the Microwave Council, Inc., was established in January 1967 by the OFMC to operate a Washington D. C., office for the purpose of maintaining complete records of private microwave stations and providing an alerting service to licensees on all new applications. Microwave Council, Inc., is to be supported by contributions from the microwave licensees and microwave manufacturers. Railroad microwave licensees have contributed \$1235.50 for this purpose through July 1967.

9. Allocations Research Council.

For the purpose of unified effort toward obtaining a more equitable division of the usable radio frequency spectrum, and thus more frequency space for the Land Mobile Radio Services including the Railroad Radio Service, the seven major national organizations of users of land mobile radio have formed the Allocations Research Council. A firm of professional consulting engineers has been engaged to conduct a study on the possibility of reallocating a portion of the UHF Television band to land mobile without disrupting the UHF-TV assignment pattern.

Exhibit 4-E

RAILROAD RADIO AUTHORIZATIONS

PART I

VHF MOBILE SERVICE (May 1967)

The following tabulation shows the total number of outstanding radio station authorizations in the Railroad Radio Service in the United States, as taken from FCC records and compiled by the Electronic Data Processing Center of the AAR.

Symbol	Classification	Number
FB	Base Stations Only	4 657
FBM	Combined Base & Mobile	379
FB2	Mobile Relay & Base	575
FX1	Control Stations	59
FX2	Fixed Relay Stations	9
MO	Mobile Only Licenses	443
Total outstanding VHF Licenses		6 122
Total mobile units authorized		68 056

PART II

RADIOLOCATION (SPEEDMETERS) (May 1967)

Outstanding Authorizations	55
Total units authorized	584

PART III

OPERATIONAL FIXED STATIONS
(INCLUDING MICROWAVE) (May 1967)

Total Outstanding Authorizations	718
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PART IV

MICROWAVE POINT-TO-POINT SYSTEMS (May 1967)

A--U.S. RAILROADS

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
Atchison, Topeka & Santa Fe 6575-6875 MHz	Chicago-Topeka, Kansas- Amarillo, Texas-Winslow, Arizona-Barstow- Los Angeles, Calif. with major spurs to Wickenburg, Arizona; Bakersfield, Calif.; and Cushenbury, Calif. San Francisco-Richmond, Calif.	2450.34 8.95
	*Stubs to Joliet and Streator, Ill.	1.76
Bay Area Rapid Transit 2110-2200 MHz	San Francisco to Mt. Diablo, Calif.	4.4
Central of Georgia 6575-6875 MHz	Macon to Savannah, Ga. Millen to Augusta, Ga. Albany to Columbus, Ga. Columbus to Bremen, Ga.	183.2 52.9 97.7 112.8
Chicago & North Western 6575-6875 MHz	Chicago, Ill. to Milwaukee, Wis. *W. Chicago, Ill. to Clinton, Iowa	118.0 106.0
Chicago, Burlington & Quincy 6575-6875 MHz	*Chicago to Galesburg, Ill.	168.0
Chicago, Milwaukee, St. Paul & Pacific 6575- 6875 MHz	Chicago to Bensenville, Ill.	15.0
Chicago, Rock Island & Pacific 6575-6875 MHz	Goodland to Phillipsburg, Kans.	135.0
Denver & Rio Grande Western 6575-6875 MHz	Pueblo to Denver, Colo. to Ogden to Salt Lake City, Utah	759.0
Grand Trunk Western 6575-6875 MHz	*Chicago to Blue Island, Ill.	16.6
Illinois Central 6575-6875 MHz	*Harahan, La. to Clinton, Miss.	173.9
1850-1990 MHz	*Clinton to Jackson, Miss.	6.1
Kansas City Southern 6575-6875 MHz	Kansas City, Mo. to Shreve- port-New Orleans, La. -- Port Arthur, Texas--Dallas, Texas	1604.0
Missouri-Kansas-Texas 6575-6875 MHz	McAlester to Muskogee, Okla.	55.3
New York Central 6575-6875 MHz	Indianapolis to Washington Twp., Ind.	12.2

* Authorized or under construction.

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
Northern Pacific 6575-6875 MHz	Seattle, Wash. to Portland, Ore. including Tacoma & Centralia, Wash.	137.5
	St. Paul, Minn. to Fargo, N.D., including Staples & Brainerd, Minn.	246.9
	*Fargo, N.D. to Billings, Mont. including Valley City, Jamestown & Mandan, N.D., Glendive & Laurel, Mont.	633.4
Northwestern Pacific 1850-1990 MHz	Willits to Eureka, Calif.	149.71
Pennsylvania 1850-1990 MHz	Phoenixville to Reading, Pa.	24.0
Reading 2110-2200 MHz	Piscataway Twp. to Port Reading, N.J.	13.6
Sacramento Northern 1850-1990 MHz	Chico to Wicks Corners, Calif.	37.0
Southern 6575-6875 MHz	Washington, D.C.; Lynch- burg & Danville, Va.; Charlotte & Ashville, N.C.; Columbia & Spartanburg, S.C.; Augusta, Atlanta, Macon, Valdosta & Adel, Ga.; Live Oak & Jackson- ville, Fla.; Chattanooga & Knoxville, Tenn.; Lexing- ton, Ky.; Cincinnati, Ohio; Birmingham, Woodstock & Mobile, Ala.; New Orleans, La.	3044.1
Southern Pacific 1850-1990 MHz	*Corpus Christi to Gregory, Texas	10.2
2110-2200 MHz	Banner Mtn. to Colfax, Calif.	10.12
	Donner Summit to Norden, Calif.	1.2
	Prospect Hill to Salem, Ore.	7.1
	Wolf Mtn. to Oakridge, Ore.	15.2
	Odell Butte to Crescent Lake, Ore.	6.0
	Odell Butte to Chemult, Ore.	18.1

* Authorized or under construction.

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
Southern Pacific 2110-2200 MHz	Lookout Hill to Lordsburg, N. Mex.	3.7
	*Mt. Ord to Alpine, Texas	11.65
	*Twin Peak to Sierra Blanca, Texas	5.5
6575-6875 MHz	Portland & Eugene, Ore.;	
	Dunsmuir, Sacramento, Oakland, San Francisco, Fresno, Burbank & Los Angeles, Calif.; Reno, Nevada; Yuma & Phoenix, Ariz.; and El Paso, Texas	2430.03
	*El Paso to Houston, Texas	749.48
Union Pacific 6575-6875 MHz	Omaha, Nebr.; Salt Lake City & Milford, Utah; Los Angeles, Calif.; Laramie, Wyo.; Pocatello, Idaho; Portland, La Grande & The Dalles, Ore.; Seattle, Ta- coma & Centralia, Wash.	2589.01
	*Cheyenne, Wyo. to Denver, Colo.	120.9
	*Omaha, Nebr. to Marysville, Salina & Kansas City, Kans.	353.5
Route Miles--U. S. Railroads		
Operational.....		14342.06
Authorized or under construction		2356.99
Total.....		16699.05

Some of the above 6000 MHz systems use frequencies in the 952-960 or 12, 200-12, 700 MHz bands for spurs or short hops, or frequencies in the 12, 200-12, 700 MHz band for diversity operation.

* Authorized or under construction.

B--CANADIAN RAILWAYS

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
Canadian National	Grand Prairie, Alta. to	
1700-2300 MHz	Alaska Border	1131.0
3900-4200 MHz	Sydney, N.S. to St. John's	
	Nfld.	573.0
5925-6425 MHz	Hay River, N.W.T.-- to	
	Grumbler Rapids, N.W.T.	64.0
1710-2290 MHz	Hay River, N.W.T.--to Lady	
(Scatter System)	Franklin Pt., N.W.T.	578.0
5925-6425 MHz	Hay River T&R, N.W.T.--	
	Hay River (Scatter Site),	
	N.W.T.	1.0
6575-6875 MHz	Pyramid, Alta.-- Jasper,	
	Alta.	6.0
6575-6875 MHz	Duff, Sask.--Melville, Sask.	12.0
6475-6875 MHz	Corner Brook, Nfld.-- Cor-	
	ner Brook (CBYT-TV),	
	Nfld.	3.0
7000-7300 MHz	Red Cliff, Nfld.-- Grand	
	Falls (CJCN-TV), Nfld.	6.0
1700-2300 MHz	Red Cliff, Nfld.-- Windsor,	
	Nfld.	6.0
7000-7300 MHz	St. John's, Nfld.-- St. John's	
	(CJON-TV), Nfld.	1.0
6575-6875 MHz	Corner Brook (T&R), Nfld.--	
	Wild Cove (COTC), Nfld.	5.0
1700-2300 MHz	Egmont, N.B.-- Summerside,	
	P.E.I.	14.0
6425-6875 MHz	St. John's, Nfld.-- St. John's	
	(CBC), Nfld.	1.0
7000-7300 MHz	Stephenville, Nfld.-- Harmon	
	Field USAFB, Nfld.	4.0
1700-2300 MHz	Milton, Ont.-- Hamilton, Ont.	17.0

Microwave Systems as operated by Canadian National and Canadian Pacific Telecommunications respectively:

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
CNT Operated		
6425-6575 MHz	Lutes Mtn., N.B. to Moncton	
	(T&R), N.B.	7.0
5925-6425 MHz	Vancouver, B.C. to Duff,	
	Sask.	1143.0

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
CNT Operated		
5925-6425 MHz	Edmonton, Alta. to Calgary, Alta.	201.0
3700-4200 MHz	Quebec, Que. to Rimouski, Que.	182.0
1700-2300 MHz	Rimouski, Que. to Mt. Car- leton, Que.-- Lutes Mtn., N.B.	302.0
3900-4200 MHz	Toronto-Hamilton-Kitch- ener-London, Ont.	135.0
5925-6425 MHz	Kitchener, Ont. to Wingham, Ont.	52.0
6425-6875 MHz	Jonquiere, Que. to Ste. Arsene, Que.	98.0
6425-6875 MHz	Ste. Arsene, Que. to Riviere du Loup, Que.	24.0
5925-6425 MHz	Toronto, Ont. to New Ore- gon, N.Y., U.S.A., Can- ada Border	97.0
CPT Operated		
5925-6425 MHz	Montreal, Que. to Duff, Sask.	1628.0
5925-6425 MHz	Spencerville, Ont. to Ot- tawa, Ont.	43.0
5925-6425 MHz	Millar Hill, Ont. to Toron- to, Ont.	119.0
5925-6425 MHz	Hazelwood, Ont. to Fort William, Ont.	12.0
5925-6425 MHz	Gunton, Man. to Winnipeg, Man.	28.0
5925-6425 MHz	Duff, Sask. to Regina, Sask.	80.0
1700-2300 MHz	London, Ont. to Windsor, Ont.	120.0
3600-4200 MHz	Montreal, Que. to Quebec, Que. (including spurs to: Sherbrooke and Three Rivers)	247.0
1700-2300 MHz	Vancouver, B.C. to Nanai- mo, B.C.	39.0
6575-6875 MHz	Sudbury, Ont. to Capreol, Ont.	15.0
Ontario Northland		
1710-2290 MHz	Cochrane to North Bay, Ont.	211.5
5925-6425 MHz	Cochrane to Lowther, Ont.	99.4
5925-6425 MHz	Cochrane to Moosonee, Ont.	179.8

<u>Railroad and Frequency Band</u>	<u>Major Terminals of System</u>	<u>Route Miles</u>
Ontario Northland		
10,700-11,700 MHz	North Milne to Sturgeon Falls, Ont.	38.4
7125-7725 MHz	*Kirkland Lake, Ont. to Noranda, Que.	47.7
Pacific Great Eastern		
5925-6425 MHz	Vancouver to Fort St. John, B.C.	616.0
	Chetwynd to Dawson Creek, B.C.	54.0
	McLeod to McLeod Lake, B.C.	10.0
	Milburn to Quesnel, B.C.	11.0
	Lone Butte to Lac La Hache, B.C.	23.0
	Mission Mtn. to Shalalth, B.C.	2.0
	Milburn to Australian, B.C.	24.0
	Williams Lake Repeater to Williams Lake, B.C.	6.0
	McLeod to Fort St. James, B.C.	60.0
	Alta Lake Repeater to Alta Lake, B.C.	4.0
Quebec North Shore and Labrador		
5925-6425 MHz	Sept Isles to Schefferville, Que.	357.0
5925-6425 MHz	Ross Bay-Labrador City	45.0
6860-6920 MHz	Labrador City-Schefferville, Que. (CFKL-TV)	163.0
Route Miles--Canadian Railroads		
Operational.....		8898.1
Authorized or under construction		47.7
Total		8945.8

Commercial traffic is carried on these Canadian systems in addition to Railway business.

* Authorized or under construction.

Exhibit 4-F

INTERIM REPORT ON SOURCES AND NATURE
OF ELECTRICAL NOISE AFFECTING RADIO RECEPTION
AND METHODS OF SUPPRESSION IN AUTOMOTIVE EQUIPMENT

In reviewing available literature* on the subject, it is evident that the majority of noise affecting radio reception emanates from motor vehicles. Power line interference, and radiation from industrial as well as professional buildings, account for a variety of random noise sources, but are not the prime offender. Motor vehicles individually and collectively are the primary consideration. They produce the constant, repetitious, sputter type impulse interference that is responsible for a general degradation of two-way vehicular radio communication.

It should be pointed out that treatment of sputter type noise will in no way prevent hiss-type noise that is inherently generated or passed by radio equipment and such treatment will only partially eliminate crash-type noise related to weather phenomena.

No two vehicles, even of the same make, require the same noise suppression measures since such noise can be caused in whole, or in part, by the ignition system; the generator; wheels; loose metal items, such as fenders, hood, etc.; accessory and blower motors; speedometers and tachometers; improperly-grounded coaxial antenna feeder; loose or defective light bulbs; defective doorlight, ignition and headlight switches; voltage regulator "feedthrough"; "floating grounds" (as found on the instrument panel); corrosion of electrical contacts through galvanic or electrolytic action; loose bonding strips at the engine proper; and ties or brakes. These sources are capable of generating both radiated noise and conducted noise. Conducted noise is a problem only within the vehicle containing the mobile installation, while radiated noise is a problem from other vehicles as well as that housing the installation.

For the most part, the vehicle housing the installation can be treated for both radiated and conducted noise by the following seven general steps, listed in the order of highest probability:

1. **Generator.** Install an $0.5 \mu f$ coaxial capacitor in series with the wire on the armature terminals and fasten the mounting bracket securely to the generator frame. Good brushes and a clean commutator are essential.

* "Man Made Noise" Working Group 3, Technical Standing Committee of the Advisory Committee for Land Mobile Radio Services, June 30, 1966. "Ignition Interference" Report of Working Group 4, International Special Committee on Radio Interference, April 25-29, 1966.

2. **Spark Plugs.** Resistor-type plugs of good quality are the most effective; however, they must be properly gapped. As an alternate, an equally good grade of suppressor-resistor of 5000 ohms for each plug and 10,000 ohms for the distributor "hot" lead is acceptable. Engine performance is not affected, since in either case the resistance merely reduces current and does not appreciably reduce ignition voltage. The metal tip on each end of the coil and plug wires must be checked to be certain that no gaps exist. Cleaning and re-soldering of wires may be necessary.

3. **Voltage Regulator.** Install an $0.5\ \mu\text{f}$ coaxial capacitor in series with the wire on the armature terminal and also a similar capacitor in series with the wire on the battery terminal of the regulator. Secure the mounting brackets to a good ground on the vehicle body close to the regulator. Also install a 3.9-ohm (approx.), 1-watt carbon resistor with one end connected to the field terminal of the regulator and the other end connected to one of the wire leads of a third $0.5\ \mu\text{f}$ coaxial capacitor. Clip off the remaining wire lead of the third capacitor and secure the mounting bracket to a good body ground.

4. **Coil.** Install an $0.1\ \mu\text{f}$ coaxial capacitor in series with the coil primary battery lead at the coil and solidly ground the mounting bracket at the nearest convenient point.

5. **Bonding.** Noises are often eliminated by bonding various portions of the vehicle together by means of a flexible tinned-copper bonding braid. A light-duty type is usually used to bond the choke, temperature and control cables to the body or frame where they pass through the firewall. A heavy-duty type should be used to bond the exhaust pipe, muffler, steering column, engine block and firewall to the vehicle frame.

6. **Gauges.** The gas, oil, heat and other gauges can be checked for noise by disconnecting temporarily while the engine is idling. Generated noise may be eliminated by installing an $0.1\ \mu\text{f}$ coaxial capacitor in series with the "hot" lead of the offending gauge at the gauge.

7. **Wheels and Tires.** Wheel noise may be eliminated by installing special spring type static collectors in the front wheel bearing caps. Tire noise may be eliminated by injecting a special graphic powder into the tires with a suitable injecting device.

It will very seldom be necessary to complete all of the above steps. Generally, satisfactory reception is obtained after completing the first three steps.

Noise reduction kits are available to suppress noise in varying degrees. These vary from simple capacitor kits to those containing complete shielding for the ignition and generator systems. It is apparent that compromise is essential in most instances, and that complete shielding is seldom required.

REPORT OF

COMMITTEE 5--INSTRUCTIONS AND SHOP PRACTICE

- O. C. French (Chairman), Supt. Sigs. Sys., Atchison, Topeka & Santa Fe Ry.
C. H. Johnson (Vice Chairman), Office Engr., St. Louis-San Francisco Ry.
G. H. Alford, Supt. Sigs. & Comms., Missouri Pacific R.R.
U. H. Auckerman, Regl. Engr. Sigs., Chesapeake & Ohio Ry.
L. G. Hogan, Sig. Shop Supt., Canadian Pacific Ry.
J. G. Karlet, Mgr. Sigs. & Comms., Norfolk & Western Ry.
W. C. McConnell, Staff Engr. - Comms. & Sigs., Pennsylvania R.R.
S. A. Means, Sig. & Elecl. Supt. - Sys., Southern Ry.
B. R. Merta, Supvr. Sigs. & Comms., Chicago, Milwaukee, St. Paul & Pacific R.R.
R. F. Miller, Supvr. Sig. Shop, Chicago, Burlington & Quincy R.R.
E. B. Platt, Asst. to Sig. Engr., Illinois Central R.R.
C. A. Prickett, Supvr. Sig. Shop, Baltimore & Ohio R.R.
L. E. Robinson, Proj. Engr., Reading Co.
C. E. Shaw, Asst. Sig Engr., Louisville & Nashville R.R.
A. P. Young, Area Supvr. of Sigs., Canadian National Rys.

Consulting Members

- R. J. Little, Stds. Engr., General Railway Signal Co.
J. E. McMahon, Jr., Mgr., Const. & Field Svc., Union Switch & Signal Div. of Westinghouse Air Brake Co.
-

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.
4. Investigate and report on communication and signal shop practices:
 - (a) Assembly of components for field installation projects.
 - (b) Repair of apparatus.
 - (c) Reclamation of material.

5. Investigate and report on noteworthy practices used in repairing communication and signal apparatus.
6. Investigate and report on devices not commercially available, used in repairing communication and signal apparatus.
7. Investigate and report on signal and/or communication repair shops.

The committee submits for consideration, reports on the following subjects:

1. Consolidation and Revision of Signal Manual Parts 3--Specification 112-52--Portable Alternating Current Ammeter; 168--Specification 85-52--Portable Direct Current Voltmeters, Ammeters and Volt-Ammeters; 169--Specification 115-52--Portable Alternating Current Voltmeter, as Exhibit 5-A, page 144.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 14--Instructions for Storage Batteries, revised as shown in Exhibit 5-B, page 148.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 54--Instructions for Light and Semaphore Signals, revised as shown in Exhibit 5-C, page 154.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 134--Instructions for Switch Circuit Controllers, revised as shown in Exhibit 5-D, page 158.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 138--Instructions for Interlockings, revised as shown in Exhibit 5-E, page 160.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 170--Voltage Ranges for Signal Work. The committee recommends that this manual part be eliminated from the Signal Manual, as all publications have now been revised to delete reference thereto.

Action Recommended

Approval for elimination from the Signal Manual.

1. Signal Manual Part 233--Instructions for Signal Protection for Movable Bridges, revised as shown in Exhibit 5-F, page 164.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

6. Method of Replacing Mast Bases, as Exhibit 5-G, page 166.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 5--INSTRUCTIONS
AND SHOP PRACTICE

Exhibit 5-A

(Consolidation and Revision of Signal Manual Parts 3, 168 and 169)

SPECIFICATION FOR PORTABLE PRECISION
ELECTRICAL INDICATING INSTRUMENTS

1967

1. Purpose.

(a) This specification is for the purpose of providing for portable direct or alternating current voltmeters, ammeters, volt-ammeters and wattmeters having a rated accuracy of 1 percent full scale value or greater.

2. Specifications.

(a) The instruments furnished on this specification shall meet the requirements of current USA Standard for Electrical Indicating Instruments, C 39.1.

3. Tender.

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. Purchaser's Order Requirements.

(a) The following additional requirements will be shown on purchaser's order:

1. Type of instrument.
2. Class of instrument as specified in paragraph 6-b.
3. Range combinations as specified in paragraph 6-c.
4. Principle of operation as specified in paragraph 6-d.
5. Push button or other type switches required.
6. Method of suspension of moving element as specified in paragraph 6-e.
7. Description of instrument case including shape, size and material, handles, feet, etc.
8. Description of carrying case or cover including hinging where required.
9. Inspection and tests as required.

5. Material and Workmanship.

(a) Material and workmanship shall be first-class in every respect.

6. Design.

(a) General.

1. Instruments shall be of a design acceptable to purchaser.

6. Design.-- Continued.

(b) Class of Instrument.

1. Instruments shall be of four general classes, all with mirror scales.

2. Class 0.1. Those having an accuracy of 0.1 percent full scale with a 12-in. minimum scale length for use as a laboratory standard.

3. Class 0.25. Those having an accuracy of 0.25 percent full scale with a 5-in. minimum scale length for use as a portable standard.

4. Class 0.5. Those having an accuracy of 0.5 percent full scale with a 3.2-in. minimum scale length for use when a relatively high degree of accuracy is desired.

5. Class 1.0. Those having an accuracy of 1.0 percent full scale with a 2.5-in. minimum scale length for use when a moderately accurate reading is acceptable.

(c) Ranges.

1. Meters shall have a self-contained maximum range of 800 volts or 50 amps as specified. For ranges above these values, an external multiplier or shunt on current transformer shall be furnished as required.

2. Preferred end scale ranges.

Full Scale Value	D-C Volt- meters	D-C Am- meters	A-C Volt- meters	A-C Am- meters	Watt- meters
1	*	*	#	*	*
1.2	-	-	-	-	#
1.5	*	#	*	#	*
2	*	*	-	*	*
2.5	-	-	-	-	#
3	*	*	*	*	*
4	-	-	-	-	#
5	*	*	-	*	*
6	-	-	#	-	#
7.5	*	-	*	-	-
8	*	#	*	#	*

* Preferred end scale ranges.

End scale ranges used but not preferred.

- Not recommended for single-range instruments.

Note 1: All ranges listed are deemed satisfactory for use of multirange instruments if they bear a ratio of 1, 2 or 5, or a decimal multiple or submultiple thereof, to a preferred range provided on the instrument.

(d) Principle of operation.

1. Electrodynamic.
2. Permanent-magnet moving coil.
3. Moving iron.

6. Design.-- Continued.

4. Induction.
5. Electrostatic.
- (e) Method of suspension of moving element.
 1. Pivot and jewel.
 2. Taut band.
- (f) Current loss.
 1. Current losses for voltage ranges of permanent-magnet moving coil instruments.
 - (a) Instruments having a minimum scale length of 3.2 in., not less than 1000 ohms per volt for voltmeters and 100 ohms per volt for volt-ammeters.
 - (b) Instruments having a minimum scale length of 2.5 in., not less than 100 ohms per volt.

7. Binding Posts.

- (a) Connection to instrument shall be made on binding posts.

8. Inspection and Tests.

(a) The product furnished under this specification may be accepted upon manufacturer's certification that it is in accordance with the specification. If on arrival at destination the product is found not to meet the requirements of the specification, it may be rejected and manufacturer, upon request, shall advise purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all transportation charges.

9. Packing.

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

10. Marking.

(a) Purchaser's order, requisition and package number, name of consignor, and name and address of consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment.

11. Warranty.

(a) The manufacturer shall warrant that the product, including all accessories and replacement parts, supplied in accordance with this specification shall be free from defects in design, material or workmanship under ordinary use and service within one year from date of acceptance. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the manufacturer thereof, so as to affect, in manufacturer's judgment, its proper functioning or reliability, nor to that which has been subjected to misuse, negligence or accident.

11. Warranty.-- Continued.

(b) The manufacturer shall covenant and agree to save harmless and indemnify the purchaser of the product against all claims, suits, actions or proceedings and all damages, costs, fees and expenses arising therefrom by reason of allegations that the product or any part thereof in and of itself infringes any patent if the purchaser notifies the manufacturer of any such claim and gives the manufacturer authority to dispose of it and to defend any suit brought thereon.

Exhibit 5-B

(Revised Signal Manual Part 14)
AAR SIGNAL INSTRUCTIONS

STORAGE BATTERIES*

1967

These instructions apply to the installation, maintenance and test of storage batteries. They set forth general requirements representing recommended practice.

1. Maintenance, tests and repair work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. To reduce danger from explosion or fire, an open flame must not be permitted near battery. Extreme care must be exercised to avoid a spark or flash when changing connections or working on or near a battery. Battery load must first be disconnected at a point remote from the battery.

3. Care must be exercised to avoid external short circuiting.

4. Electrolyte is highly corrosive and therefore must be handled carefully to avoid injury to person or damage to clothing or equipment.

5. If electrolyte is accidentally spilled on skin or clothing, it must be flushed with water immediately.

6. Battery must be arranged to permit access for cleaning and inspection.

7. Connectors, jumper lugs, cell posts and their contacting surfaces must be clean. Cell posts and connecting bolts must be tight and should be coated as instructed.

8. Housing containing batteries must be adequately ventilated.

9. Charging wires should preferably be connected directly to the battery terminals. The positive wire must be connected to the positive terminal. Polarities may be determined by meter test.

10. Batteries must not be overcharged or undercharged continuously.

11. Excessive gassing must be avoided.

* The term "as instructed" as used herein refers to individual railroad instructions.

12. Water used in battery must be either distilled or from a source which has been tested and approved for storage battery use. Water must be kept only in approved containers.

13. Add water to each cell often enough to maintain electrolyte level at approximately recommended height. When water is added in cold weather, the electrolyte must be agitated with hydrometer syringe to mix the water with the electrolyte to prevent freezing of the water.

14. Metals must not be used to stir electrolyte.

15. Electrolyte recommended by manufacturer must be used. Special solutions, powders, jellies, or other additives must not be used.

16. Cells showing irregularities, which cannot be corrected, must be taken out of service and report made to proper authority.

17. Defective containers must be removed from service.

18. Approved hydrometers and thermometers must be used.

19. Hydrometers, thermometers, or other utensils used for one type of electrolyte must not be used for any other type.

20. Meters of an approved type must be used, checked frequently and calibrated when necessary.

21. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

22. When cells with steel outer containers are used, metal objects must not be allowed to rest across or fall between them.

23. Steel containers must be kept clean and should be painted with alkaline resistant paint to prevent rust damage.

24. When batteries are received with shipping seals or plugs in place, these must be removed before placing batteries in service. Care must be used in removing the plugs to prevent damage to skin or clothing.

Nickel, Iron, Alkaline Type

25. The range of specific gravity of electrolyte at correct solution height, as recommended by manufacturer, with battery fully charged must be maintained in accordance with the following table:

Maximum recommended gravity (solution at recommended level)				
Temperature of electrolyte	Standard, or low, type cells	High and High Wide Type Cells		Minimum recom- mended gravity, all type cells
		High Type B, Size 1 only	Other Cells	
43 C (110 F)	1.217	1.195	1.202	1.147
38 C (100 F)	1.220	1.198	1.205	1.150
32 C (90 F)	1.222	1.200	1.207	1.152
27 C (80 F)	1.225	1.203	1.210	1.155
21 C (70 F)	1.227	1.205	1.212	1.157
16 C (60 F)	1.230	1.208	1.215	1.160
10 C (50 F)	1.232	1.210	1.217	1.162
4 C (40 F)	1.235	1.213	1.220	1.165
- 1 C (30 F)	1.237	1.215	1.222	1.167
- 7 C (20 F)	1.240	1.218	1.225	1.170
-12 C (10 F)	1.242	1.220	1.227	1.172
-18 C (0 F)	1.245	1.223	1.230	1.175

For variations in solution height, 0.005 should be added to the hydrometer reading for each 1/4 in. above normal height and subtracted for each 1/4 in. below to obtain the specific gravity at recommended level.

26. When the specific gravity has reached approximately the minimum recommended gravity at correct solution height, the electrolyte should be renewed in accordance with manufacturer's instructions, or as instructed.

27. The specific gravity of electrolyte does not indicate the state of charge. Specific gravity readings should be taken, as instructed, preferably in the fall, to determine the condition of the electrolyte.

28. Cells taken out of service for a period of 2 months or more must be discharged at the normal rate to 0.5 volt per cell and then short-circuited in groups of not more than five series-connected cells. They must be stored in a dry place and care exercised to see that electrolyte does not fall below the top of the plates.

29. Before restoring a cell to service that has been stored in a completely discharged condition, the electrolyte must be raised to the correct level. The cell must then be given a charge equivalent to a charge at the normal 7-hr. charging rate for 15 hrs.

Nickel, Cadmium, Alkaline Type

30. The range of specific gravity of electrolyte at correct height, as recommended by manufacturer, with battery fully charged must be maintained in accordance with the following tables:

Normal Electrolyte for Southern Temperatures

Temperature of electrolyte	Recommended specific gravity
42 C (108 F)	1.150-1.190
31 C (88 F)	1.155-1.195
20 C (68 F)	1.160-1.200
9 C (48 F)	1.165-1.205
- 2 C (28 F)	1.170-1.210

Arctic Electrolyte for Northern Temperatures

Temperature of electrolyte	Recommended specific gravity
42 C (108 F)	1.201-1.241
31 C (88 F)	1.206-1.245
20 C (68 F)	1.211-1.251
9 C (48 F)	1.215-1.255
- 2 C (28 F)	1.221-1.261

31. When water is added to cells to maintain the recommended solution level, cells must be left in service at least 24 hrs. to thoroughly mix added water.

32. The specific gravity of electrolyte does not indicate the state of charge.

33. Specific gravity readings should be taken, as instructed, preferably in the fall, to determine the condition of the electrolyte.

34. Adjust float charge to maintain a reading of 1.40-1.45 volts per cell.

35. Excessive salt formation on cell tops indicates that cells are being overcharged. The salt is noncorrosive, does no damage, and is easily brushed off.

36. Following is a high rate charge table, as recommended by manufacturer, for discharged batteries of various ampere-hour capacities:

Battery capacity, ampere-hours	Recommended charging rate
25	5 amps for 7 hrs.
52	11 amps for 7 hrs.
80	16 amps for 7 hrs.
95	19 amps for 7 hrs.
120	24 amps for 7 hrs.
140	28 amps for 7 hrs.
160	32 amps for 7 hrs.

37. When the specific gravity has reached approximately the minimum recommended gravity at correct solution height, the electrolyte should be renewed in accordance with manufacturer's instructions, or as instructed.

Lead Acid Type

38. All cells to be placed in service must be tested to determine that the specific gravity is within the range specified on the name plate or in the instructions, this usually being 1.200 to 1.220 at 25 C (77 F). If any cells are found to be below this range, they must be recharged as instructed.

39. Specific gravity readings must be taken, as instructed, with electrolyte at correct height and corrections made for temperature as follows:

(a) To correct hydrometer reading to normal temperature of 77 degrees fahrenheit, subtract one point (0.001 specific gravity) for each 3 degrees fahrenheit.

(b) To correct hydrometer reading to normal temperature of 25 degrees centigrade, subtract three points (0.003 specific gravity) for each 5 degrees centigrade.

EXAMPLE:

45 C	-	add 12 points	-	113 F
35 C	-	add 6 points	-	95 F
25 C	-	no correction	-	77 F
15 C	-	subtract 6 points	-	59 F
5 C	-	subtract 12 points	-	41 F

40. Elements must not be exposed to the air.

41. Battery temporarily stored must be put in a dry, clean location where temperature is above freezing and, if practicable, below 32 C (90 F).

42. Battery not placed in service within a reasonable length of time must be given a charge periodically and if specific gravity drops below 1.180, recharge battery as instructed.

43. Electrolyte lost due to spillage must be replaced with the proper amount of electrolyte of the same specific gravity as that of other cells of the battery. Under no other circumstances must electrolyte be added. In emergency, where level is below top of plates, add water as a temporary measure to prevent the plates from becoming dry.

44. When mixing sulphuric acid with water, pour acid slowly into water while thoroughly stirring with glass or hard rubber paddle until the proper specific gravity has been reached. Water must not be poured into acid.

45. Fresh mixed electrolyte must not be placed in cells until it has cooled.

Exhibit 5-C

(Revised Signal Manual Part 54)
AAR SIGNAL INSTRUCTIONS

LIGHT SIGNALS*

1967

These instructions apply to the installation, maintenance and test of light signals. They set forth general requirements representing recommended practice.

General.

1. Work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary work, repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Each circuit, the functioning of which affects the safety of train operations, must be kept free of any ground or combination of grounds which will permit a flow of current equal to or in excess of 75 percent of the release value of any relay or other electromagnetic device in the circuit, except circuits which include any track rail and except the common return wires of single-wire, single-break, signal control circuits using a grounded common, and alternating current power distribution circuits which are grounded in the interest of safety.

3. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

4. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.

5. Signal mechanisms, signal housings and instrument housings must be locked, or sealed, as instructed.

6. Components which fail to perform their intended functions must be adjusted, repaired or replaced, without undue delay.

7. Defective reflectors, lenses, roundels or cover glasses must be replaced as instructed, and without undue delay.

* The term "as instructed" as used herein refers to individual railroad instructions.

General. --Continued

8. Action must be taken when necessary to prevent improper aspect due to reflection of external light.
9. Mast must be vertical, mounted on suitable support and securely fastened. Signal must be aligned to display the best possible aspect for approaching trains.
10. Ladder steps, hand railing and platform must be kept in good condition and securely fastened.
11. Lenses, reflectors, roundels, cover glasses and lamps must be cleaned as instructed. Where practicable, lenses, reflectors and roundels should be cleaned without removing incandescent lamp or disturbing adjustment of light unit.
12. Housings must be kept clean and not used for storing material, tools or supplies unless special provision is made. They should not be opened in stormy weather, except when conditions require.
13. Paint must be applied as instructed.
14. Inspections and tests must be made and results recorded as instructed, and values maintained in accordance with the Table of Operating Characteristics for the type of signal tested.
15. Manufacturer's instructions must be followed unless they conflict with these general or detailed instructions, in which case proper authority must be consulted for correct procedure.
16. Electric lamps must be maintained and tested in accordance with Instructions for Incandescent Electric Lamps, Manual Part 120.
17. Where deflecting or spreadlight prisms are used, care must be exercised to see that they are assembled and maintained to deflect or spread the light beam in the proper direction.

Color light signal--searchlight types.

18. Operating mechanisms, when placed in service, must meet shop requirements specified in the Table of Operating Characteristics for the particular type of signal.
19. Operating mechanisms not meeting field requirements specified in Table of Operating Characteristics must be removed from service without undue delay and defects noted on authorized repair tag.
20. Working voltage of operating mechanism must be maintained as closely as practicable to rated voltage. Where separate armature and field windings are used, low current in one element must not be compensated for by increasing the current in the other element above its rated limit.
21. Operating mechanism and reflector unit must be securely fastened in place.
22. Changes and adjustments of the internal parts of the signal, including the lens and lamp receptacle, must not be made from their original settings.

Color light (other than searchlight types), position light and color position light signals.

23. Changes and adjustments of the internal parts of the signal, including the lens and lamp receptacle, must not be made from their original settings, except that lamp receptacle may be changed or reset where provision has been made for proper focusing.

24. Door or cover of lamp unit of color light signal must be kept closed when train is approaching.

TABLE OF OPERATING VALUES OF COLOR LIGHT SIGNAL MECHANISMS - SEARCHLIGHT TYPE

Shop Requirements							Field Requirements				
Normal resis- tance	Initial charge		Minimum drop-away		Maximum pick-up and working		Minimum drop-away		Maximum pick-up and working		
Ohms	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	Volts	Amps	
3 INDICATIONS WITH PERMANENT MAGNET--WITHOUT CONTACTS											
250	11.0	0.014	2.6	0.0104	5.5	0.022	2.1	0.0084	6.5	0.026	US&S H, H2 or H5
500	16.0	0.032	3.8	0.0076	8.0	0.016	3.0	0.006	9.0	0.018	US&S H, H2 or H5
3 INDICATIONS WITH PERMANENT MAGNET--WITH CONTACTS											
250	11.0	0.014	2.0	0.008	5.5	0.022	1.6	0.0064	6.5	0.026	US&S H, H2 or H5
500	16.0	0.032	3.0	0.006	8.0	0.016	2.4	0.0048	9.0	0.018	US&S H, H2 or H5
250	9.0	0.036	2.12	0.0085	6.0	0.024	1.7	0.0068	7.2	0.029	GRS SA, SA1
430	13.3	0.031	3.14	0.0073	8.13	0.0189	2.51	0.0058	9.76	0.0227	GRS SA
105	5.67	0.054	1.35	0.0128	3.45	0.0328	1.08	0.0102	4.14	0.0394	GRS SA
380	11.8	0.031	2.81	0.0074	7.3	0.0192	2.25	0.0059	8.8	0.023	GRS SA

Note: The resistance of the coils may vary 10 percent, therefore the current or voltage may vary accordingly.

Exhibit 5-D

(Revised Signal Manual Part 134)
AAR SIGNAL INSTRUCTIONS

SWITCH CIRCUIT CONTROLLERS*

1967

These instructions apply to the installation, maintenance and test of switch circuit controllers.† They set forth general requirements representing recommended practice.

1. Work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary work, repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Circuit controllers must be positioned as instructed and securely fastened in place.

3. Circuit controller must be installed and maintained so that the contacts will be positioned as instructed.

4. Circuit controller connected at the point of switch, split point derail, or movable point frog, must be maintained so that its contacts will not be in position corresponding to switch point closure when switch point is open 1/4 in. or more.

5. Circuit controller operated by an independently operated derail, other than the split point type, must be maintained so that the normally open contacts will remain closed and normally closed contacts will remain open when controller connecting rod movement exceeds 1 in. toward nonderailing position.

6. Tests must be made as instructed to determine that:

(a) Movement of train over switch, derail, or movable point frog will not cause contacts to open or close improperly.

(b) Circuit controller contacts meet resistance requirements.

7. Contacts must be kept clean and in proper adjustment as instructed. Contact opening must be not less than 1/16 in. when open.

8. Movable parts must be kept clean, properly adjusted and lubricated as instructed.

9. Components which fail to perform their intended functions must be adjusted, repaired or replaced without undue delay.

* The term "as instructed" as used herein refers to individual railroad instructions.

† Instructions for circuit controllers within switch-and-lock movements or facing point locks are covered in Instructions for Interlockings, Manual Part 138.

10. Covers, gaskets and fastenings must be kept in good condition to prevent the entrance of moisture, dirt, etc.
11. Ventilator screens and gaskets must be in place and kept free of paint or other obstruction.
12. Wire and cable entrances must be properly sealed to prevent entrance of moisture, rodents, insects, etc.
13. Threads of rods, jaws and bolts must be kept clean and properly lubricated.
14. Paint must be applied as instructed.
15. Where circuit controllers are equipped with centering attachments, they must be maintained and tested as instructed. They may be tested by disconnecting the operating rod and moving the crank by hand to the full normal position and then to the full reverse position. When released from either position, it should assume an approximate vertical position. When released, the contact must be open for a normal or reversed closed circuit, or closed if a part of the track shunting circuit.
16. Where an insulated ball stud is used in the operating crank, it must be given an insulation test as instructed.
17. Circuit controllers removed from service for repairs must be returned with full information as required on authorized repair tag or as instructed.
18. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

Exhibit 5-E

(Revised Signal Manual Part 138)
AAR SIGNAL INSTRUCTIONS

INTERLOCKINGS*

1967

These instructions apply to the installation, maintenance and test of interlockings. They set forth general requirements representing recommended practice.

General.

1. Work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary work, repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Before removing rails, switch points or frogs, protecting signals must display their most restrictive indication. Signals must not be restored to normal operation until tests have been made and it is known that they function as intended and that the track is safe for train operation.

3. In case of severe storm, inspection must be made and trouble corrected as instructed.

4. Each circuit, the functioning of which affects the safety of train operations, must be kept free of any ground or combination of grounds which will permit a flow of current equal to or in excess of 75 percent of the release value of any relay or other electromagnetic device in the circuit, except circuits which include any track rail and except the common return wires of single-wire, single-break, signal control circuits using a grounded common and alternating current power distribution circuits which are grounded in the interest of safety.

5. Each wire must be tagged or otherwise marked so it can be identified at each terminal. Nomenclature must correspond to that of the circuit plan. Tags or other marks of identification in instrument cases and apparatus housings must be made of insulating material. Wires, tags, or other markings must not interfere with moving parts of apparatus.

6. Control machine cabinets and instrument housings must be locked or sealed as instructed.

* The term "as instructed" as used herein refers to individual railroad instructions.

General. -- Continued.

7. Doors, covers and fastenings must be kept in good condition, with suitable gaskets in place.
8. Contacts must be kept clean and in proper adjustment as instructed.
9. Lightning arresters must be properly connected, maintained and tested as instructed.
10. Components which fail to perform their intended functions must be adjusted, repaired or replaced, without undue delay.
11. Housings must be kept clean and must not be used for storing material, tools or supplies unless special provision is made. They should not be opened in severe or stormy weather, except when conditions require.
12. Paint must be applied as instructed.
13. Signal apparatus must be maintained as instructed so as to conform to established clearances for equipment.
14. Locking dog of switch-and-lock movement must enter the lock rod $1/2$ in. or more before circuit controller can indicate lock position either normal or reverse.
15. Switches, movable point frogs and split point derails must be maintained so that they cannot be locked if the switch point is prevented by an obstruction from closing to within $1/4$ in.
16. Point detector must be maintained so that when switch mechanism is locked in normal or reverse position, contacts cannot be opened by manually applying force at the closed switch point. Point detector circuit controller must be maintained so that the contacts will not assume the position corresponding to switch point closure if the switch point is prevented by an obstruction from closing to within $1/4$ in. where latch-out device is not used, and to within $3/8$ in. where latch-out device is used.
17. Holes or notches in lock rods must have square edges and must not be more than $3/16$ in. larger than the locking bar or plunger.
18. Edges of locking dogs and rods of switch-and-lock movement or facing point lock must be maintained with not more than $1/16$ in. wear.
19. Associated apparatus must be maintained and tested in accordance with the following instructions:

	Manual Parts
(a) Cells and Batteries	7 & 14
(b) Incandescent Electric Lamps	120
(c) Insulated Rail Joints	133
(d) Rectifiers and Motor-Generators	68
(e) Relays	124 & 126
(f) Time Release Applied to Signal Apparatus	128
(g) Light Signals	54
(h) Switch Circuit Controllers	134
(i) Track Circuits	8

General. --Continued.

Manual Parts

(j) Wire and Cable	190
(k) Made Grounds	61
(l) Insulation Resistance Testing	130
(m) Spring Switches	140
(n) Facing Point Locks Applied to Spring Switches	159
(o) Electric Locking	199
(p) Signal Protection for Movable Bridges	233

20. Operations recorder, where used, must be checked for proper operation as instructed.

21. At automatic interlocking, tests must be made as instructed to determine that:

(a) A loss of shunt for 5 seconds or less will not permit an established route to be changed.

(b) When any track circuit between home signals on any route is occupied, home signals for all conflicting routes, and for the route occupied, cannot be cleared.

22. Restoring feature on power switches must be tested to determine that power will restore switch movements to normal or reverse position.

23. Results of inspections and tests herein required and all other inspections and tests that may be required must be recorded as instructed.

24. When necessary to work on switch-and-lock movements, energy must be removed, as instructed, until the work is completed.

25. Switch-and-lock movements must be maintained in accordance with manufacturer's instructions, or as instructed.

Electro-pneumatic equipment.

26. Air compressor intakes must be kept clean and free from dirt and moisture. Intake must not be close to the ground, or where moisture accumulates. Nothing should be done which might obstruct or increase the resistance of air intakes.

27. Condensers, tanks, reservoirs and air distribution lines must be drained frequently to avoid overflow of condensation into branch lines and apparatus. Means of draining condensation out of distribution system must be provided and maintained at low points.

28. Special attention must be given to drainage of condensation from air systems throughout the period of the year when temperatures are above freezing so as to avoid interruptions during cold weather.

29. Air distribution systems must be maintained so that leakage in any section of the system will not exceed 1 lb. in 1 minute at normal pressure with all apparatus connected and at rest.

30. Inside of pipe and fittings must be kept free from iron cuttings, scale, dirt, paints, or pipe joint compounds.

31. Air strainers used between air distribution system and air

Electro-pneumatic equipment. --Continued.

apparatus must be cleaned frequently to avoid air pressure reduction.

32. Oil used in piping system or internal parts of valves, cylinders and other apparatus, must be of a grade which will not disintegrate nor injure packing.

33. Pickup and release of valve magnets must be tested as instructed and values maintained within the limits recommended by manufacturer.

34. Valves and cylinders must be tested to determine that parts are clean, packing tight, air supply unrestricted and apparatus functions properly.

35. When necessary to clean or repair valves and cylinders, they must be removed from service and the work performed as instructed.

Electric switch and lock movements.

36. Operating mechanisms must be operated by hand after making adjustments to see that they operate properly and without undue strain on any part before being operated by power and then by power from the control point for checking operation after making adjustments.

37. Contactors must not be operated manually, except when out of service.

38. Commutator must be smooth, clean and have a glossy appearance. To clean, lift brushes from commutator and use cham-
ois or cloth free from lint and abrasives.

39. Brushes must be kept clean, fitted to commutator, free in brush holder, or brush holder free on stud. Springs must be in place and maintained so that brushes will have proper bearing and pressure. When installing new brushes, they should be placed in position and carefully seated on the commutator by placing No. 000 or finer sandpaper under the brush with smooth side against the commutator, and while pressing brush oscillate sandpaper with commutator. Burrs must be removed from the brush. When finished, all sand and dust must be removed.

40. Friction clutch in switch and lock movements must be checked and adjusted in accordance with manufacturer's instructions, or as instructed. Overload relays must be checked for proper operation.

41. Magnetic detent must be checked for proper operation as instructed.

Exhibit 5-F

(Revised Signal Manual Part 233)
AAR SIGNAL INSTRUCTIONS

SIGNAL PROTECTION FOR MOVABLE BRIDGES*

1967

These instructions apply to the installation, maintenance and test of signal protection for movable bridges. They set forth general requirements representing recommended practice.

1. Work which may interfere with safe operation of trains must not be started until train movements have been fully protected. Temporary work, repairs or adjustments, when required, must be made in such manner that safety of train operation will not be impaired. When repair, adjustment, change or replacement is made, tests must be made immediately to determine that the apparatus functions as intended. When making tests of apparatus, proper instruments must be used and it must be known that no unsafe conditions are set up by the application of testing equipment.

2. Bridge and rail locks must be installed and maintained to secure and lock the bridge and movable bridge rails when they are in proper position, as follows:

(a) Bridge lock or bridge lock mechanism must be checked so that the bridge locking mechanism cannot be locked unless the movable members are within 1 in. of full-locked position.

(b) Rail lock mechanism when used must be checked so that it cannot be locked with the rail displaced $\frac{3}{8}$ in. or more from its proper position.

3. Equipment for checking and controlling operation of the bridge must be installed and maintained so that the operation of each device occurs in a predetermined sequence.

4. Apparatus must be installed and maintained to insure that before a signal governing train movements over the bridge can display an aspect to proceed, the bridge is locked in accordance with Instruction 2-a and the track rails on the movable span are within $\frac{3}{8}$ in. of correct surface and alinement with rail seating device on bridge abutment or fixed span.

5. At the time tests are being made, careful examination of the locks and parts effective in the locking must be made to determine that they are properly lubricated and in good working order. When defective or improper operation or condition in bridge or rail locking is found, measures must be taken to protect train movements and proper authority notified.

* The term "as instructed" as used herein refers to individual railroad instructions.

6. Each circuit controller for signal circuits must be maintained so that its contacts will not close unless the bridge and rails are in proper position for train operation.

7. Signal protection for movable bridges must be maintained and tested in accordance with these instructions and also insofar as they apply:

(a) Instructions for Automatic Block Signal Systems, Manual Part 102.

(b) Instructions for Interlockings, Manual Part 138.

8. Results of inspections and tests required must be recorded as instructed.

Exhibit 5-G

METHOD OF REPLACING MAST BASES

A base and welding jig is being used by an Eastern Railroad for replacement of broken bases or where a section of mast immediately above top of base has deteriorated due to rust, corrosion, etc., and is unsuitable for service.

Details of welded steel bases are shown in Fig. 1. Jigs for 5 and 6 in. diameter mast are shown in Figs. 2 and 3. Details for jigs are shown in Figs. 4 and 5.

These bases and jigs may be constructed in most Signal Shops or at closest heavy maintenance shops. Parts for jigs and bases are sheared from standard size steel plates, and holes are punched or drilled. There is little waste material.

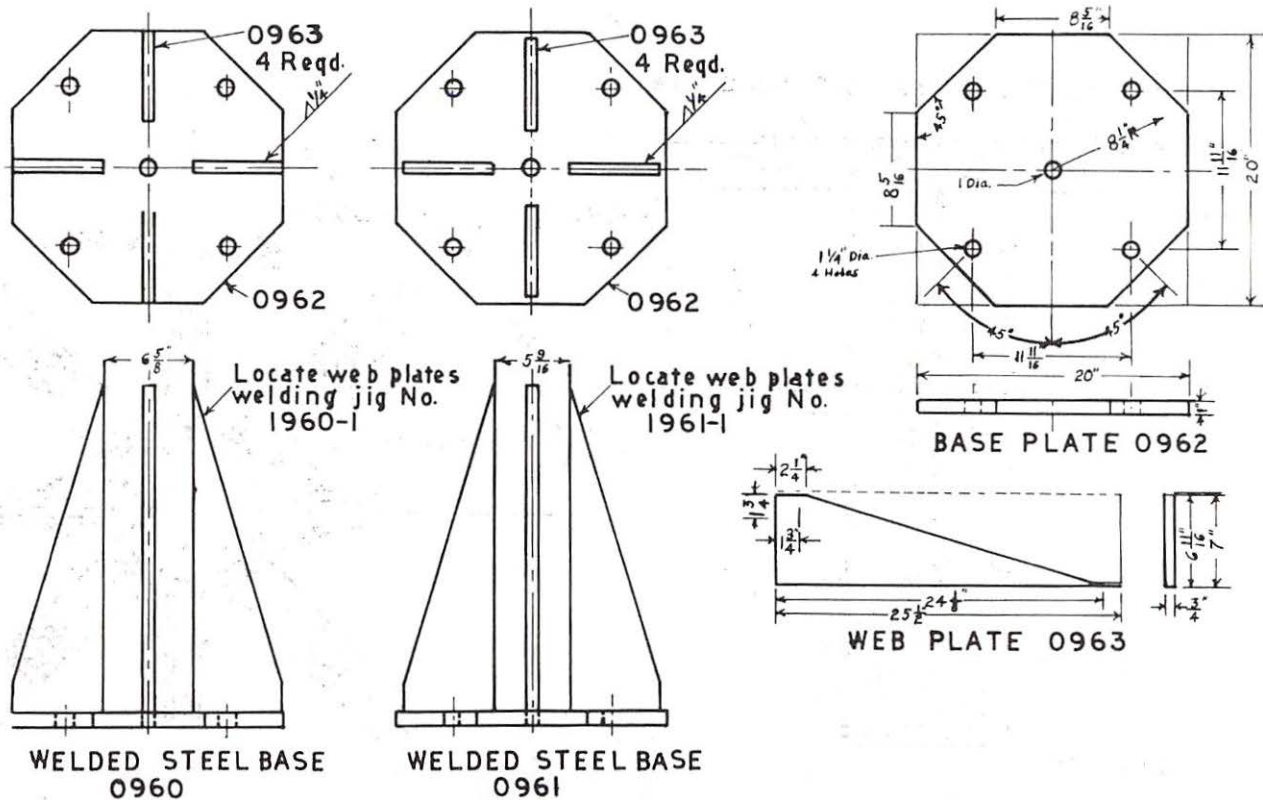
Any employee with ordinary welding skill and the aid of this jig can prepare a base and apply it to a pole.

These bases may be applied to masts of any length up to 38 ft. Ladder and platform assemblies are easily adapted. By setting up a modified standard for pole heights, Fig. 6, this railroad has been able to salvage many poles for further service.

The use of these bases results in substantial savings over purchase of new mast and ladder assemblies; also, delivery time is a factor in an emergency.

This base has been tested and approved by this railroad and is also used by a number of utility companies.

Fig. 1



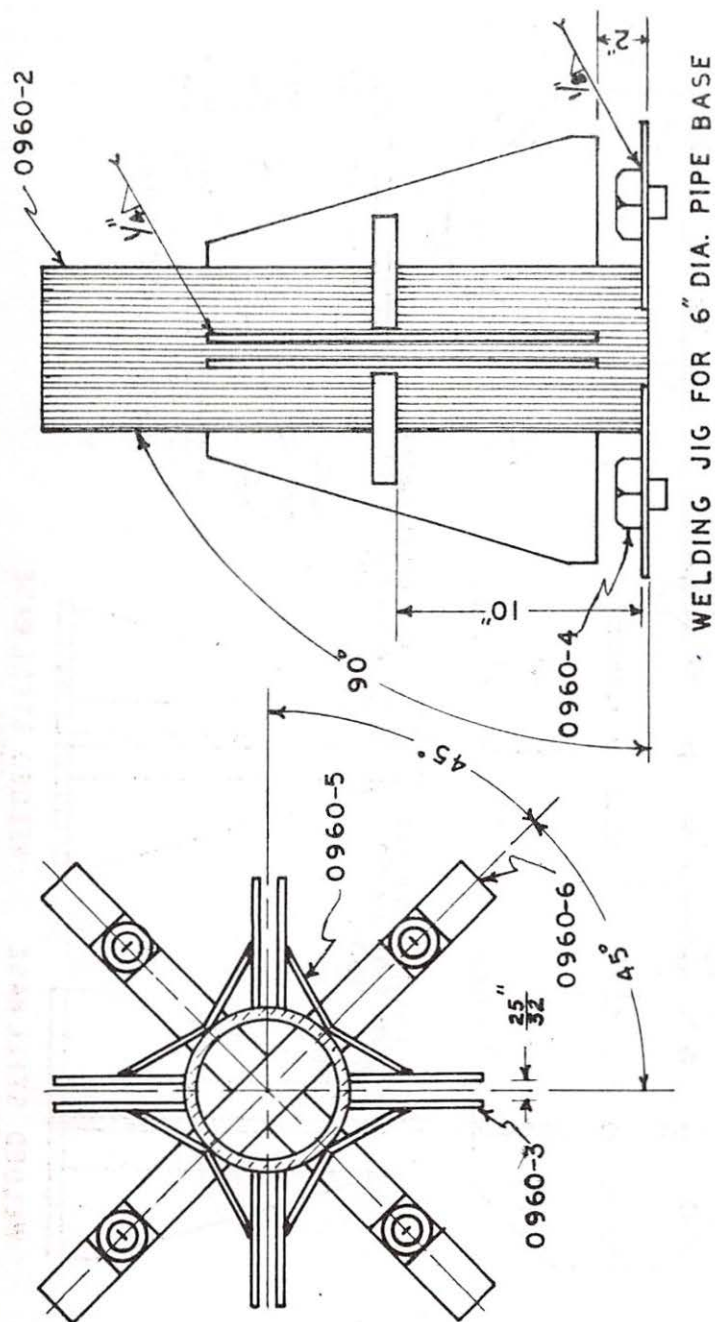


Fig. 2

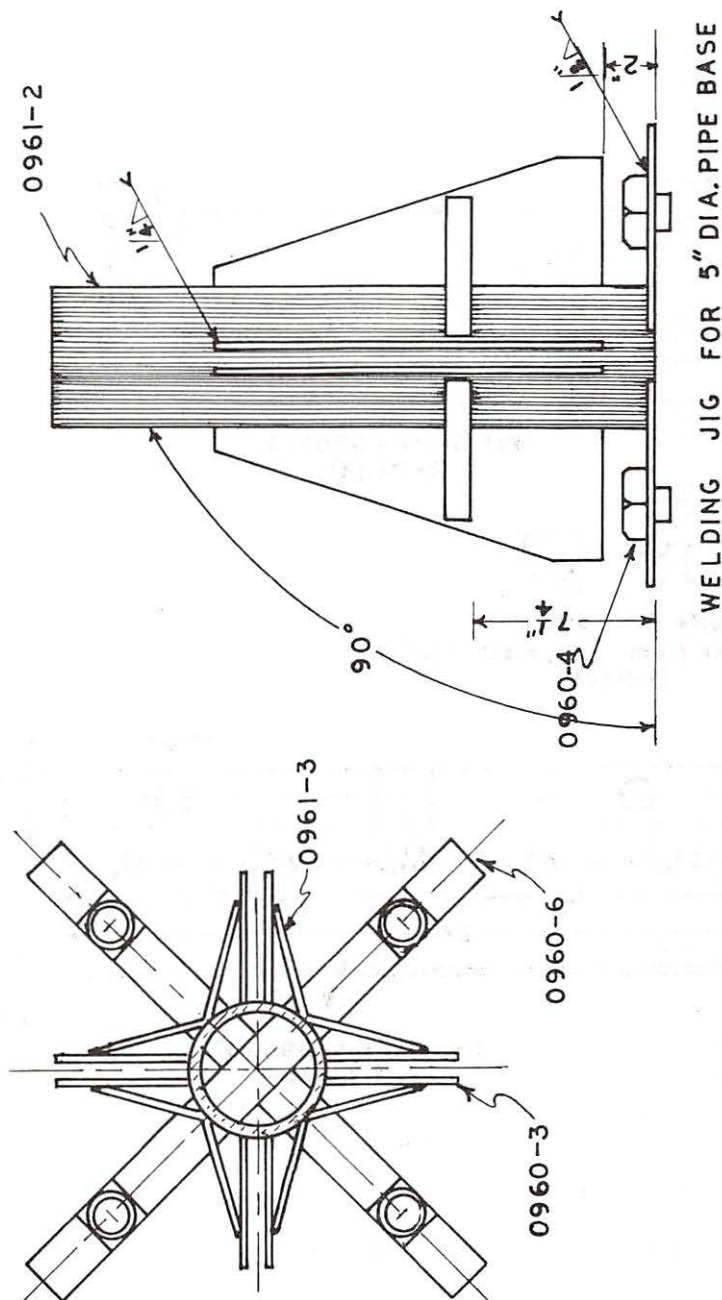
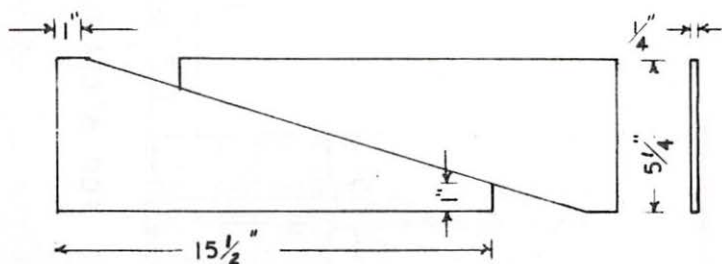
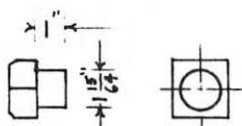


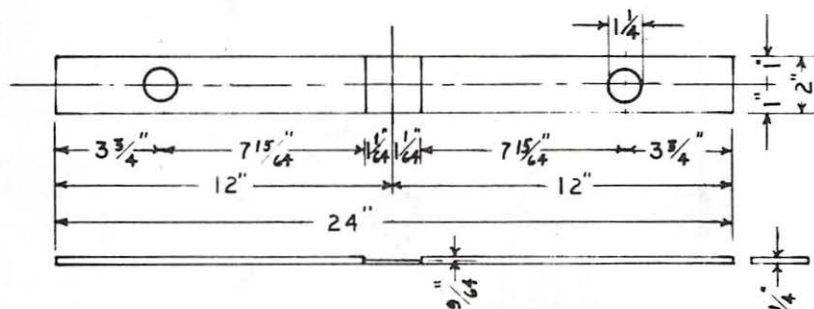
Fig. 3



Web Guide - 0960-3
(8 - Req'd.)

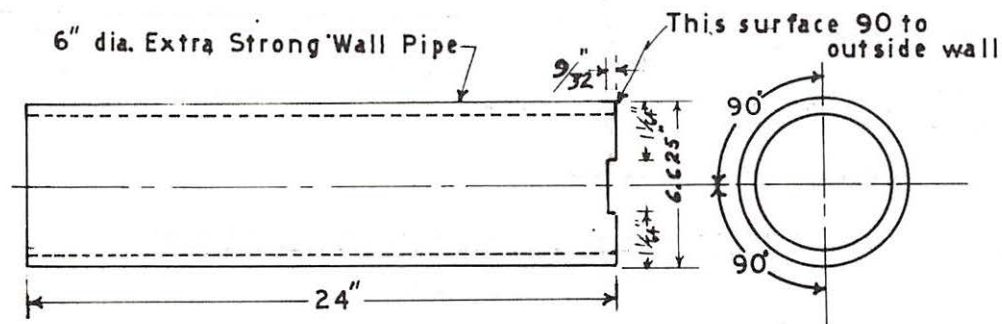


Guide Pin - 0960-4
(Make from 1/4" dia. mach. bolt)
(4 - Req'd.)



Gauge Foot - 0960-6
(2 - Req'd.)

Fig. 4



Mast Gauge - 0960-2

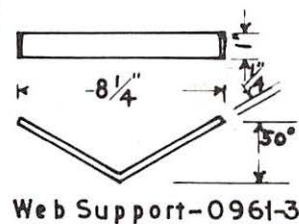
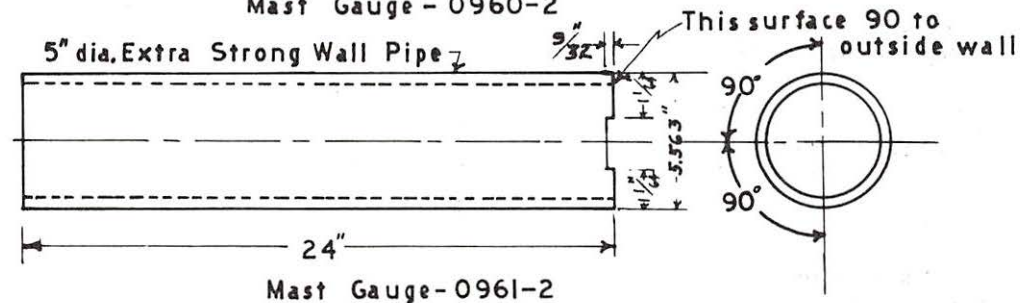
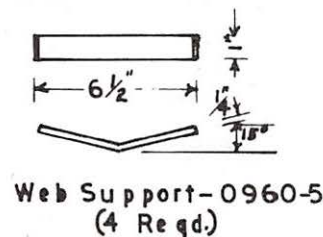


Fig. 5

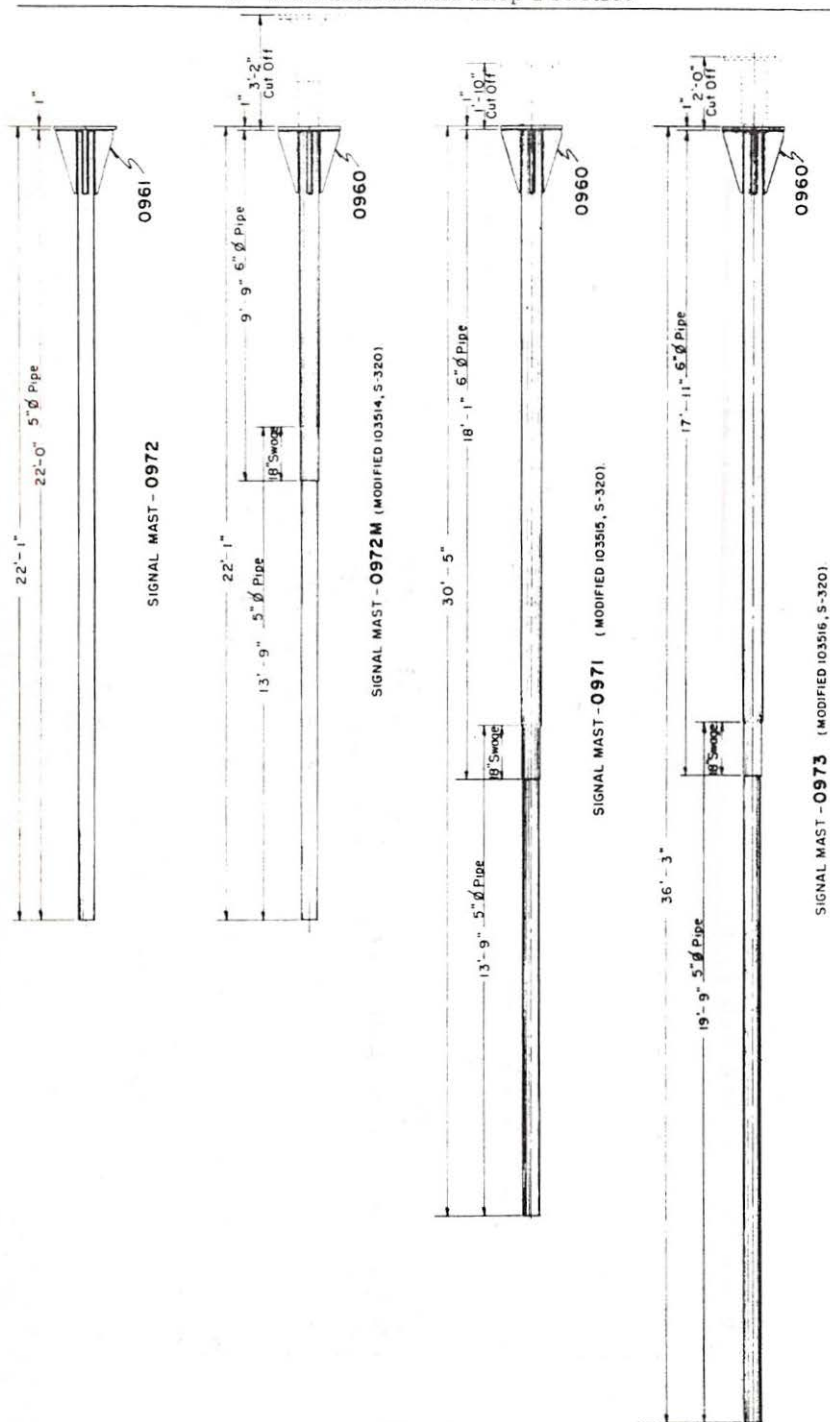


Fig. 6

REPORT OF
COMMITTEE 6--DESIGNS

- R. L. Bush (Chairman), Asst. Sig. Engr., Chicago & North Western Ry.
H. L. Kruke (Vice Chairman), Asst. Engr. Sigs., Chicago, Milwaukee, St. Paul & Pacific R.R.
P. A. Brady, Office Engr., Comms. & Sigs., Erie Lackawanna R.R.
J. F. Derochie, Traffic Control Engr., Missouri Pacific R.R.
D. W. Greaves, Engr. - Sigs., Pennsylvania R.R.
J. E. Harney, Asst. to Supt. Sigs. Sys., Atchison, Topeka & Santa Fe Ry.
H. L. Hinton, Asst. Regl. Engr. Sigs. & Comms., Norfolk & Western Ry.
D. L. Johnson, Asst. Sig. Engr., Chicago, Rock Island & Pacific R.R.
V. A. McGregor, Asst. Sig. Engr., Canadian National Rys.
W. R. Parker, Asst. Engr. Sigs., Illinois Central R.R.
J. P. Powell, Engr. Sigs. - Sys., Louisville & Nashville R.R.
L. A. Sebeczek, Office Engr., Sig. Dept., Chicago, Burlington & Quincy R.R.
J. A. Tilton, Asst. Regl. Engr. Sigs. & Comms., Norfolk & Western Ry.
P. L. Wheeler, Engr. Sig. Dvlpt. & Design, Chesapeake & Ohio Ry.

Consulting Members

- G. O. Ferm, Commercial Dept., General Railway Signal Co.
R. L. Henderson, Application Engr., Transportation Industry, Large Lamp Dept., General Electric Co.
R. J. Little, Sds. Engr., General Railway Signal Co.
J. E. McMahon, Jr., Mgr., Const. & Field Svc., Union Switch & Signal Div. of Westinghouse Air Brake Co.
C. L. Steinmetz, Sales Engr., Railroad Accessories Corp.
J. J. Van Horn, Chf. Engr., Sigs. & Comms., Western Railroad Supply Co.

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Designs.
4. Typical circuits representing current practice for railway signaling.
5. Simplification of sizes and kinds of electric lamps for signal purposes, collaborating with Purchases and Stores Division, AAR.
6. Investigate and report on means and methods to extend the life of incandescent electric lamps used in signaling.
8. Collaborate with AREA:
 - (a) Committee 4--Rail.
 - (b) Committee 5--Track.
10. Prepare specification for plastic roundels for highway crossing signals.
12. Cooperate with National Bureau of Standards--Standardization of Signal Light Colors.
14. Investigate and report on use of plastic lenses, roundels and cover glasses for signals used in train operation.
15. Prepare a style standard for preparation of slides, designating size of slides, size of letters, lines, etc., for use in presentations at meetings of the Section.

The committee submits for consideration, reports on the following subjects:

1. Signal Manual Part 267--Specification 250-49--Pressure Gun Grease, revised as shown in Exhibit 6-A, page 176.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Drawing 1542B--Incandescent Electric Lamps--Bases, revised as shown in Exhibit 6-B, page 179.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

4. Typical Circuits Representing Current Practice for Railway Signaling. The committee has revised Typical Circuit Drawings 8000A, 8001A, 8003A, 8007A and 8009B, and their addendums.

The Secretary will notify those who have purchased the complete Typical Circuits of the availability of these revisions when they are ready for distribution.

Action Recommended

Acceptance as information.

14. Use of Plastic Lenses, Roundels and Cover Glasses for Signals Used in Train Operation, as Exhibit 6-C, page 180.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 6--DESIGNS

Exhibit 6-A

(Revised Signal Manual Part 267)

SPECIFICATION FOR PRESSURE GUN GREASE -
LIME SOAP BASE

1967

1. Purpose.

(a) This specification is for the purpose of providing a lime soap base grease suitable for application, by means of either hand or power-operated pressure guns, to car retarders and other signal apparatus as recommended by manufacturer of the apparatus. It sets forth specific detail requirements representing modern signal practice.

2. Specifications.

(a) Specifications referred to in the body of this specification form an essential part hereof.

3. Tender.

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. Material and Workmanship.

(a) Material and workmanship shall be first-class in every respect.

(b) The grease shall be a homogeneous mixture of refined mineral oil and lime soap. It shall show a minimum degree of separation of the constituents over long periods of time either in storage or in use, and shall not harden with age or exposure. It shall not contain any gritty substance, graphite or fillers, such as clay, talc, mica or gypsum. It shall not corrode metals under normal operating conditions.

(c) The grease shall conform to the following requirements:

1. Mineral oil: 89 percent by weight minimum.
2. Lime soap: 11 percent by weight maximum.
3. Moisture: 1.50 percent maximum.
4. Corrosive compounds: None.
5. Free acid as oleic: 0.30 percent by weight maximum.
6. Free alkali as calcium hydroxide: 0.15 percent by weight maximum.
7. Consistency: Worked penetration 310-340 at 25 C (77 F).
8. Dropping point: 85 C (185 F) minimum.
9. Freezing: The grease shall not freeze or become solid at -34 C (-30 F).

4. Material and Workmanship. --Continued.

(d) The mineral oil used shall conform to the following requirements:

1. Flash point: 177 C (350 F) minimum.
2. Fire point: 199 C (390 F) minimum.
3. Pour point: -26 C (-15 F) maximum.
4. Viscosity: S. U. at 38 C (100 F), 275-500 seconds.

5. Inspection and Tests.

(a) The product furnished under this specification may be accepted upon manufacturer's certification that it is in accordance with the specification. If on arrival at destination the product is found not to meet the requirements of the specification, it may be rejected and manufacturer, upon request, shall advise purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all transportation charges.

(b) All tests, except tests for freezing, shall be made in accordance with current ASTM method:

1. Analysis - ASTM D 128.
2. Consistency - ASTM D 217.
3. Viscosity - ASTM D 88.
4. Pour point - ASTM D 97.
5. Free acid and uncombined alkali - ASTM D 128.
6. Moisture - ASTM D 95.
7. Corrosive compounds - ASTM D 130*.
8. Flash and fire - ASTM D 92.
9. Dropping point - ASTM D 566.

(c) Test for freezing shall be conducted as follows:

1. Freezing.

Fill an ASTM pour test jar (1-1/4 in. diameter, 5 in. high) up to the graduation line (2-1/8 in. from the bottom) with the grease to be tested. Insert an ASTM low cloud and pour test thermometer. Cool this jar and a brass rod 1/4 in. diameter by suitable means to -34 C (-30 F), and hold at this temperature for at least 1 hr. Withdraw the thermometer and insert in its place the brass rod. If the rod can be moved through the grease, the grease is considered as not being frozen or solid at this temperature.

* Tests for corrosive compounds similar to test for corrosive compounds in gasoline.

6. Containers.

(a) Grease shall be furnished in clean, dry containers with tight replaceable covers, to protect against loss or damage during shipment.

7. Packing.

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

8. Marking.

(a) Purchaser's order, requisition and package number, name of consignor and name and address of consignee, shall be plainly marked on outside of package, case or drum.

(b) Detail list of containers and their contents shall be furnished for each shipment.

9. Warranty.

(a) The manufacturer shall warrant that the product supplied in accordance with this specification shall be free from defects. This warranty shall not apply to any product which shall have been altered in any way by anyone other than the manufacturer thereof, so as to affect, in manufacturer's judgment, its proper functioning or reliability, nor to that which has been subjected to misuse or negligence.

Exhibit 6-B

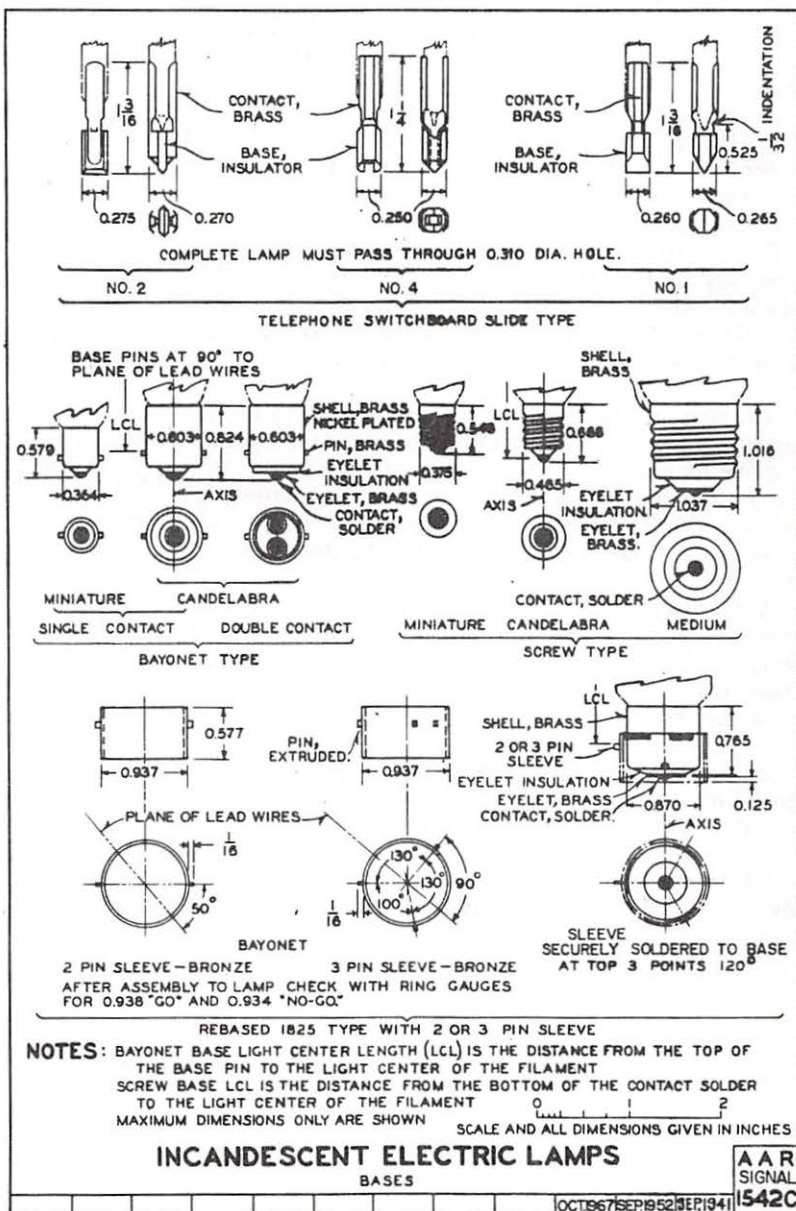


Exhibit 6-C

USE OF PLASTIC LENSES, ROUNDELS AND
COVER GLASSES FOR SIGNALS USED
IN TRAIN OPERATION

In response to questionnaire (Circular No. C&S-180, dated September 14, 1966) sent to all Senior Representatives, sixty-nine Member Roads furnished information.

Seven railroads reported that they are using color lenses. Of these seven, five are using the lenses in electrically-lighted signals and two as unlighted markers for semaphore signals and switch targets. Two railroads considered the lenses on trial. Each railroad reported that they are satisfied with results to date.

The use of clear plastic covers on signals for the purpose of reducing breakage, particularly breakage because of vandalism, is more extensive. Thirty-two railroads indicated that they are using clear plastic covers, with twelve considering them to be on trial. One railroad makes permanent use of plastic cover glasses and trial use of colored plastic lenses.

A summary of comments indicates reasonable satisfaction. Breakage has been substantially reduced, but not eliminated. However, one Southwestern Railroad reported that they have discontinued use of a clear plastic cover because it turned yellow around the outer edges.

Twenty-nine railroads reported that they are not using plastic lenses or cover glasses for signals used in train operation. Two railroads reported that they do not use signals.

While not related to this assignment, twenty-two railroads advised that they are using plastic lenses in highway crossing signals.

REPORT OF

COMMITTEE 7--INSIDE PLANT

- A. S. Walker (Chairman), Gen. Inside Plant Engr., Telecomms. Dept., Canadian Pacific Ry.
- E. F. Hutchinson (Vice Chairman), Asst. Gen. Supt. Comms., Chicago, Burlington & Quincy R.R.
- E. C. Anderson, Jr., Asst. Comms. Engr., Chesapeake & Ohio Ry.
- G. A. Baldy, Asst. Supt. of Comms., Great Northern Ry.
- M. L. Clawson, Comms. Engr., Chicago, Rock Island & Pacific R.R.
- F. K. Cramer, Comm. & Sig. Engr., Soo Line R.R.
- J. M. Francis, Asst. Regl. Engr. Sigs. & Comms., Norfolk & Western Ry.
- C. J. Hanna, Mgr. Comms. Svcs., Baltimore & Ohio R.R.
- J. W. Hinkle, Supt. Sigs. & Comms., Texas & Pacific Ry.
- G. L. Hitt, Engr. of Comms., Illinois Central R.R.
- R. A. Howell, Gen. Supvr. Comms., Southern Ry. System
- R. M. Laurenson, Supt. Comms., St. Louis-San Francisco Ry.
- D. R. Weems, Supt. Comms., Atchison, Topeka & Santa Fe Ry.
- F. R. Wix, Asst. Engr. of Comms. - Inside Plant, Louisville & Nashville R.R.

Consulting Members

- R. A. Clark, Jr., Pres., Communication Equipment & Engineering Co.
 - T. B. Collins, Jr., Staff Engr. - Transmission, Automatic Electric Co.
 - G. Hayes, Jr., Field Engr., Lynch Communication Systems, Inc.
 - D. R. Herdine, Cent. Dist. Ind. Sales Mgr., Lenkurt Electric Co., Inc.
 - L. C. McGee, Sales Mgr., R. W. Neill Co.
 - E. Meyers, Engr., American Telephone & Telegraph Co.
 - R. M. Peters, Vice Pres., Opns., R. W. Neill Co.
 - R. W. Pouk, Industrial Sales Engr., Stromberg-Carlson Corp.
 - G. Ramsey, Rectifier-Capacitor Div., Fansteel Metallurgical Corp.
 - A. C. Schwager, Mgr., R.R. Sales, Graybar Electric Co., Inc.
-

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.
4. Investigate and report relative to recent developments in power supply equipment.
 - (a) Rectifiers.
 - (b) Inverters.
 - (c) Converters.
 - (d) Stabilized power supply.
 - (e) Others.
5. Investigate and report with respect to the installation and maintenance of new types of batteries now available.
6. Prepare a report of general informational character covering all types of carrier systems available.
7. Recommend equipment design for carrier device to transmit combined analog and digital data for hot box detectors.
10. Prepare specification covering replacement of polar relays used in teleprinter, telegraph carrier and data transmitting equipment with solid state switching devices.
15. Investigate and report on train annunciator devices for remote indication.
16. Prepare evaluation form to be used in determining major transmission and equipment features of carrier equipment.
17. Prepare requisites for battery charging equipment for use on microwave station batteries that will meet the needs of the system.
18. Investigate and report on, and if deemed necessary, prepare specification for, techniques and devices to improve effectiveness of inside plant equipment and routines.
 - (a) Investigate and report on radio control using railroad telephone dispatching circuits.
 - (b) Investigate and report on solid state automatic telephone exchanges.
19. Investigate and report on, and if deemed necessary, prepare requisites on, single-frequency in-band signaling equipment.
20. Investigate and report on, and if deemed necessary, prepare requisites for, applying single-frequency signaling equipment, compandors, and four-wire terminating sets to circuits switched through PABX equipment.

21. Investigate and report on Translators (Code Conversion devices).
22. Investigate and report on solid state selectors and polling devices.
23. Investigate and report on all types of data subset (interface) equipment.
24. Investigate and report on readout devices for hot journal detectors.
25. Investigate and report on wind-driven power plants for remote microwave repeaters.
26. Investigate and report on developments in facsimile equipment.

The committee submits for consideration, reports on the following subjects:

1. **Manual Parts to be eliminated from the Communication Manual.** The committee recommends elimination of the following manual parts from the Communication Manual, as they are no longer current recommended practice.

- 2-G-18--Specification for Twelve-Ply Cable Sewing Twine.
- 2-G-20--Specification for Rosin Core Solder ARA-1-A.
- 2-G-24--Specification for Cross-Connecting Rings AAR-3-A and AAR-4-A.
- 2-H-2--Joint Occupancy of Buildings for Communication, Signal or Other Electrical Apparatus.
- 2-H-9--Specification for the Installation of Cable Racks and Ducts.
- 2-K-34--Specification for Testing, Adjusting and Maintaining Polar Relays, Types 1-F and 17B.
- M-1--Typical Communications Department Organization.

Action Recommended

Approval for elimination from the Communication Manual.

Respectfully submitted,

COMMITTEE 7--INSIDE PLANT

REPORT OF

COMMITTEE 8--HIGHWAY GRADE CROSSING PROTECTION

- J. W. Gavey (Chairman), Proj. Engr. - Sigs., Western Pacific R.R.
R. B. Whalen (Vice Chairman), Field Engr. - Sigs., Boston & Maine Corp.
W. E. Blevins, Office Engr. - Sigs., Missouri Pacific R.R.
C. P. Darrough, Public Projs. Engr. Sig., Southern Pacific Co.
J. A. Early, Engr., Comms. & Sigs., Pennsylvania R.R.
E. W. Horning, Crossing Protection Engr., Chicago & North Western Ry.
B. J. Hutton, Sig. Engr., Atchison, Topeka & Santa Fe Ry.
R. W. Kile, Sig. Engr., Illinois Central R.R.
E. A. Krause, Sig. Engr., Union Pacific R.R.
L. V. Lockhart, Regl. Sig. Engr., Canadian National Rys.
C. J. Mullen, Supvr. Comms. & Sigs., Central Vermont Ry.
D. E. Peterson, Asst. Sig. Engr., Northern Pacific Ry.
D. H. Thomsen, Asst. to Sig. Engr. Sys., Burlington Lines
H. W. Trawick, Engr. of Sigs., Canadian Pacific Ry.
C. N. Tymeson, Chf. Circuit Engr., Baltimore & Ohio R.R.
H. P. Warren, Asst. Engr. Sigs., Chicago, Milwaukee, St. Paul & Pacific R.R.
R. B. Waterman, Asst. Supt. Comms. & Sigs., Seaboard Air Line R.R.

Consulting Members

- A. E. Brewer, Utilities Engr., Missouri State Highway Dept.
J. K. Gibson, Prin. Transportation Engr., Public Utilities Commission, State of California.
L. H. Hawkins, Chf. Sig. Engr., Board of Transport Commissioners for Canada.
W. H. Kirley, Dir., Div. of Ry. & Bus Utilities, Massachusetts Dept. of Public Utilities.
R. J. Little, Stds. Engr., General Railway Signal Co.
R. J. Marks, Mgr. Applications Engrg., R.R. Prods. Div., The Marquardt Corp.
J. E. McMahon, Jr., Mgr., Const. & Field Svc., Union Switch & Signal Div. of Westinghouse Air Brake Co.
L. H. McNally, Chf. Engr., Minnesota Railroad & Warehouse Commission.
C. L. Steinmetz, Sales Engr., Railroad Accessories Corp.
J. J. Van Horn, Chf. Engr., Sigs. & Comms., Western Railroad Supply Co.
D. H. Worcester, Gen. Sig. Supvr., Chicago Transit Authority.
-

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.
4. Investigate and report on noteworthy developments in highway grade crossing protection.
6. Investigate and report on methods to improve effectiveness of railroad-highway grade crossing protection devices.
10. Investigate and report on highway grade crossing protection devices for light traffic lines.
12. Investigate and report on interconnection of highway grade crossing protection devices with street traffic signals.
13. Report on federal, state, dominion, and other organizational activities relating to crossing protection.
14. Prepare an information report showing how installation and maintenance costs of highway crossing protection devices are allocated between railroads and public bodies having jurisdiction.
15. Investigate agreements covering crossing protection projects with outside parties and make recommendations on suggested standard clauses.

The committee submits for consideration, reports on the following subjects:

1. Signal Manual Part 44--Specification 159-59--Railroad-Highway Grade Crossing Signs, revised as shown in Exhibit 8-A, page 188.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 274--Requisites for Control of Automatic Highway Grade Crossing Signals and Devices, revised as shown in Exhibit 8-B, page 194.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Drawings to be eliminated from the Signal Manual. The committee recommends the elimination of the following drawings, as they are no longer current recommended practice.

- 1464A--Cross-Arm and Brackets for Extended Lights--
For Flashing Light Highway Crossing Signal--De-
tails.
- 1657E--Cross-Arms--For Flashing Light Highway Crossing
Signals--4 to 8 Inch Pipe--Details.

Action Recommended

Approval for elimination from the Signal Manual.

1. Revised Signal Manual Drawings.

- 1463C--Cross-Arm for Extended Lights--For Flashing
Light Highway Crossing Signal With Pedestal Mount-
ed Gate--Assembly, page 197.
- 1468C--Cross-Arm for Suspended Lights--For Flashing
Light Highway Crossing Signal With Mast Mounted
Gate--Assemblies, page 198.
- 1656F--Cross-Arm for Suspended Lights--For Flashing
Light Highway Crossing Signals Without Gates--4
to 8 Inch Pipe--Assemblies, page 199.
- 1700C--Front and Back Plates for Number of Tracks Sign--
Reflector Unit Type--Details, page 200.
- 1719C--Number of Tracks Sign--Reflex-Reflecting Sheet
Type for 4 to 8 Inch Pipe--Detail and Assembly,
page 201.
- 1727B--Plates for 90° Railroad Crossing Sign--Extruded
Aluminum--Reflex-Reflecting Sheet Type--Details,
page 202.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

3. Annual Cost of Automatic Highway Grade Crossing Protection Devices Exclusive of Installation Costs, as Exhibit 8-C, page 203.

Action Recommended

Acceptance as information.

6. Method to Improve Effectiveness of Railroad-Highway Grade Crossing Protection, as Exhibit 8-D, page 204.

Action Recommended

Acceptance as information.

12. Interconnection of Highway Grade Crossing Protection Devices With Street Traffic Signals, as Exhibit 8-E, page 208.

Action Recommended

Acceptance as information.

13. State Activities Relating to Crossing Protection, as Exhibit 8-F, page 211.

Action Recommended

Acceptance as information.

13. Status of Stop on Red Signal Sign in Various States, as Exhibit 8-G, page 213.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 8--HIGHWAY
GRADE CROSSING PROTECTION

Exhibit 8-A

(Revised Signal Manual Part 44)

SPECIFICATION FOR RAILROAD-HIGHWAY
GRADE CROSSING SIGNS

1967

1. Purpose.

(a) This specification is for the purpose of providing for signs of various designs for railroad-highway grade crossing protection. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for replacement on existing installations when general renewal or replacement is to be made.

2. Specifications and Drawings.

(a) Specifications and drawings referred to in the body of this specification form an essential part hereof.

(b) Manufacturer shall furnish with his tender, drawings forming an essential part thereof.

3. Tender.

(a) The tender shall be for a product meeting the requirements of this specification in its entirety.

4. Purchaser's Order Requirements.

(a) The following additional requirements will be shown on purchaser's order:

1. Specific detail part references as shown on drawings for:

(a) Reflector unit type.

1. Vitreous enamel finish for front plate.

2. Synthetic enamel finish for front plate.

(b) Reflex-reflecting sheet type.

1. Flat single plate, aluminum.

2. Extruded section, aluminum.

(c) Numeral for number of tracks.

2. Drawing reference details as required for 90 deg. railroad crossing signs:

(a) Reflector unit type--assembly--Drawing 1642.

(b) Reflector unit type, front plates--details--Drawing 1643.

(c) Reflector type back plates--details--Drawing 1701.

(d) Reflex-reflecting sheet type, extruded aluminum section--assembly--Drawing 1726.

(e) Reflex-reflecting sheet type, extruded aluminum section--details--Drawing 1727.

4. Purchaser's Order Requirements. --Continued.

3. Drawing reference details as required for Number of Tracks signs:

(a) Reflector unit type--assembly--Drawing 1645.

(b) Reflector unit type front and back plates--details--Drawing 1700.

(c) Numerals--details--Drawing 1650.

(d) Reflex-reflecting sheet type, flat plate, aluminum--detail and assembly--Drawing 1719. *R-4-a-3-d.

4. Drawing reference details as required for adapter clamps and bolts:

(a) Single adapter clamp for signs--4 to 8-inch pipe--details--Drawing 1647.

5. Inspection and tests as required.

6. Alternate requisites as required.

5. Alternates.

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by purchaser's order for the provisions contained in this specification.

6. Material and Workmanship.

(a) Material and workmanship shall be first-class in every respect.

(b) Unless otherwise specified on drawings, castings, extrusions and sheet metal shall be as follows:

1. Gray iron castings shall be in accordance with Specification for Gray Iron Castings, Manual Part 88, Class 20.

2. Aluminum castings shall be in accordance with ASTM current Specification B 26, alloy S5A.

3. Extruded aluminum shall be in accordance with ASTM current Specification B 221, alloy GS10A-T42, T5 or T6.

4. Sheet steel for parts having synthetic enamel finish shall be No. 16 U.S. Standard Gage.

5. Sheet iron for parts having vitreous enamel finish shall be No. 16 U.S. Standard Gage and of the grade known to the trade as "enameling stock."

6. Sheet aluminum shall be in accordance with ASTM current Specification B 209, alloy GS11A-T6.

(c) Reflector units, where used, shall be in accordance with Manual Part 43, of proper diameter to fit 33/64 in. holes for 4 in. letters and 45/64 in. holes for 5-1/2 in. letters and numerals.

*Alternate Requisites section.

6. Material and Workmanship. --Continued.

(d) Reflex-reflecting sheet material, where used, shall be in accordance with Manual Part 276.

7. Reflector Unit Assembly.

(a) Reflector units shall be held in a fixed relation to the aperture with their axes normal to the face of the sign.

(b) Reflector units shall be readily removable for replacement when the front plate is taken off. When mounted from the rear, they shall be held in position to facilitate assembly.

(c) Reflector units shall project not more than 3/8 in. outside of aperture.

8. Front Plates and Back Plates.

(a) The front plate shall be attached to the back plate by bronze or stainless steel screws and nuts of theft-resisting type which cannot be removed with ordinary pliers, wrench or screw driver.

9. Aluminum Unit Assembly.

(a) Cast-iron adapter clamps conforming to Drawing 1647 shall be used to attach sign to mast. *R-9-a.

(b) The face of cast-iron adapter clamp shall be covered by a washer, Drawing 1647, detail 16478, or by other protective means to prevent electrolytic action between dissimilar metals.

(c) The unit assembly of sheet or extruded section should be attached to the adapter clamp by aluminum, galvanized or cadmium plated steel bolts, nuts and washers to prevent electrolytic action between dissimilar metals.

10. Welding.

(a) Support straps, where called for, shall be securely welded to the sheet metal by methods which will provide a firm bond without warpage. If spot welding is used, it shall be applied at intervals no greater than 4-1/2 in., starting 5/8 in. from each end. Prior to welding, the surface of the sheet metal and the strap shall be treated with a suitable primer paint and the welding done while primer is wet.

11. Painting.

(a) All metal surfaces shall be thoroughly cleaned in order to secure a suitable surface for painting.

(b) Paint used shall be in accordance with the following specifications:

1. Primer--Type III, Manual Part 65, or approved equivalent.

* Alternate Requisites section.

11. Painting.--Continued.

2. White--Manual Part 235.

3. Black--Manual Part 235.

(c) Sheet steel signs of reflector unit type, requiring synthetic enamel finish, shall be painted as follows:

1. Front plates.

(a) One coat of primer, in accordance with paragraph 11-b-1, applied to all surfaces.

(b) Three finish coats of white, in accordance with paragraph 11-b-2, applied to all surfaces.

(c) Two finish coats of black, in accordance with paragraph 11-b-3, applied to the letters, over the white coats.

2. Back plates.

(a) One coat of primer, in accordance with paragraph 11-b-1, applied to all surfaces.

(b) Three finish coats of white, in accordance with paragraph 11-b-2, applied to all surfaces.

(d) Signs of reflex-reflecting type, aluminum sheet and extruded section need not be painted, but should be cleaned, and etched or coated with wash primer prior to application of reflex-reflective sheeting in accordance with manufacturer's recommendations for applying such sheeting.

(e) All letters and numerals shall be true as to edge and form, and holes for reflector units shall be evenly spaced with reference to the edges.

12. Vitreous Enamel Finish.

(a) Prior to the application of the vitreous enamel coatings, the metal shall be thoroughly cleaned to free it of all foreign substances, such as dirt, scale and grease, by immersion in an acid bath followed by proper washing and neutralization.

(b) After the piece has been properly pickled, a grip or ground coat shall be applied by spraying. This coat shall be applied to all parts of the piece--front, back, sides and edges. When fused, the ground coat shall present a lustrous, continuous surface of vitreous enamel over all parts of the sign, of uniform thickness and free from blisters, copperheads, or other defects which would permit of access or contact of the atmosphere with the steel.

(c) Where white is called for on drawings, it shall consist of two coats separately applied and fused.

(d) Where black is called for, it shall consist of two coats separately applied and fused.

(e) The enamel application shall be as thin as practicable to insure a strong, tenacious covering which will be resistant against abrasion and chipping.

12. Vitreous Enamel Finish.--Continued.

(f) Great care shall be exercised to prevent the formation of heavy enamel in the openings in the plate. All holes for reflector units shall be carefully wiped for a distance of 1/8 in. around the edge of the hole in order to provide a uniform diameter and to prevent the accumulation of enamel around the hole edges.

(g) All letters and numerals shall be true as to edge and form, and holes for reflector units shall be evenly spaced with reference to the edges.

(h) Plates shall be free from objectionable warpage.

13. Reflex-Reflecting Sheet Finish.

(a) Reflecting material shall be for background only as called for on drawings.

(b) Prior to application of reflex-reflecting sheet, the signs shall have complete treatment in accordance with section 11 as required.

(c) The reflex-reflecting sheet shall be in accordance with Manual Part 276, and shall be cut with square corners for application to the entire front surface of the front plate except for a space of approximately, but not less than, 1/16 in. from the edges.

(d) The adhesive backing shall be activated by the prescribed solvent or by heat, and the sheeting then applied by hand roller, squeeze roller or vacuum applicator to form a durable bond and not closer than 1/16 in. to any edge of plate.

(e) Lettering conforming to drawing shall then be applied over the reflex sheeting, by use of pre-cut synthetic lettering film having adhesive backing, or by use of heavy black paste enamel applied with a silk screen process.

(f) All letters and numerals shall be true as to edge and form, and shall be edge-sealed in accordance with manufacturer's recommendations.

14. Inspection and Tests.

(a) The product furnished under this specification may be accepted upon manufacturer's certification that it is in accordance with the specification. If on arrival at destination the product is found not to meet the requirements of the specification, it may be rejected and manufacturer, upon request, shall advise purchaser what disposition is to be made of the rejected product. Manufacturer shall pay all transportation charges.

15. Packing.

(a) Product shall be so assembled or packed as to permit convenient handling and to protect against loss or damage during shipment.

16. Marking.

(a) Purchaser's order, requisition and package number, name of consignor, and name and address of consignee, shall be plainly marked on outside of packages and on tags attached to loose pieces.

(b) Detail list of loose pieces, packages and their contents shall be furnished for each shipment. Where carload shipments are made, routing and car identification shall be shown.

17. Warranty.

(a) The manufacturer shall warrant that the product, including all accessories and replacement parts, supplied in accordance with this specification shall be free from defects in design, material or workmanship under ordinary use and service within two years from date of acceptance. This warranty shall not apply to any product which shall have been repaired or altered in any way by anyone other than the manufacturer thereof, so as to affect, in manufacturer's judgment, its proper functioning or reliability, nor to that which has been subjected to misuse, negligence or accident.

(b) The manufacturer shall covenant and agree to save harmless and indemnify the purchaser of the product against all claims, suits, actions, or proceedings and all damages, costs, fees and expenses arising therefrom by reason of allegations that the product or any part thereof in and of itself infringes any patent if the purchaser notifies the manufacturer of any such claim and gives the manufacturer authority to dispose of it and to defend any suit brought thereon.

Alternate Requisites.

R-4-a-3-d.

Reflex-reflecting sheet type, extruded aluminum sections-- details and assembly--Drawing 1719.

R-9-a.

Cast-aluminum adapter clamps, similar to Drawing 1647, shall be used to attach sign to mast.

Exhibit 8-B

(Revised Signal Manual Part 274)

AAR SIGNAL REQUISITES

CONTROL OF AUTOMATIC HIGHWAY GRADE
CROSSING SIGNALS AND DEVICES

1967

1. Purpose.

(a) These requisites are for the purpose of setting forth the recommended general requirements for control of automatic highway grade crossing signals and devices. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made

2. Signals and Devices.

(a) For highway crossing signals and devices, see Requisites for Highway Grade Crossing Signals and Devices, Manual Part 148.

3. General.

(a) Signals and devices which indicate the approach of a train shall be so controlled that they will operate for such period of time before the arrival of any train operated over the crossing as is reasonably required to afford protection.

(b) Controls shall be in accordance with Requisites for Automatic Block Signaling Circuits, Manual Part 34, in so far as they apply, and as far as practicable shall be so designed that in the event of failure of any part, the required operating time of the signals and devices will be provided.

(c) Where means are provided for cutting out the protective devices during intervals when trains make regular operating stops or perform switching operations on approach circuits:

1. Controls shall be designed to provide that signals are again operating before train enters crossing.

2. Automatic control of the protective devices actuated by approaching trains other than the train that has stopped or is performing switching operations, shall take precedence over any cutout features.

(d) Where manual supervisory control of protective devices is provided in addition to automatic controls:

1. Automatic control actuated by approaching trains other than that for which manual control has been made effective shall take precedence over the manual control.

3. General.--Continued.

2. Means shall be provided to make certain that the controls are restored to automatic operation.

3. Means shall be provided to prevent manual operation by unauthorized persons.

(e) Where highway traffic or other conditions warrant and highway traffic signals are located within 200 ft. of a railroad-highway grade crossing which is provided with automatic highway grade crossing signals:

1. Means may be provided to preempt the control of the highway traffic signals by the control of the grade crossing signals.

2. Where controls are so arranged they shall conform to the general principles set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways, prepared by the National Joint Committee on Uniform Traffic Control Devices.

4. Controls for Highway Grade Crossing Signals.

(a) Where the greatest distance along the highway is 35 ft. or less between either signal and the clearance beyond the furthest track from such signal on which trains operate at medium or higher speed, the signals shall operate for not less than 20 seconds before arrival of any train on such tracks. Where this distance is more than 35 ft., the 20 seconds time should be increased to provide the additional time required for highway vehicles to pass this clearance.

(b) Signals shall operate until the rear of the train clears the crossing on main tracks over which trains normally operate in either direction, and for trains moving with the current of traffic on main tracks over which trains normally operate in one direction only.

(c) Where reverse running is frequent on main tracks, consideration shall be given to meeting the same requirement as where trains normally operate in either direction on main track.

(d) Where train speeds on a given track vary considerably, a single operating circuit of such length as to provide adequate warning of the approach of trains at the higher speed may produce too long a warning time for slower trains. In such cases, additional operating circuits may be provided with timing devices so arranged that a warning time, not too long for the slower trains, will be automatically selected.

(e) Bell, when used with devices other than gates, shall sound a warning from time signals start to operate to at least the time head end of train has passed the crossing.

5. Controls for Automatic Gates.

(a) Gate arm lights shall operate in conjunction with the highway grade crossing signal, as follows:

1. Lights shall operate at all times when the gate is in position to obstruct highway traffic.

2. Light nearest the tip of arm shall burn steadily.

3. Two lights shall flash alternately and in unison with the lights on the signal.

(b) Gate arm shall start its downward motion not less than 3 seconds after the signal lights start to operate.

(c) Gate arm shall reach full horizontal position before arrival of any train on a main track and shall remain in that position until the rear of the train has cleared the crossing.

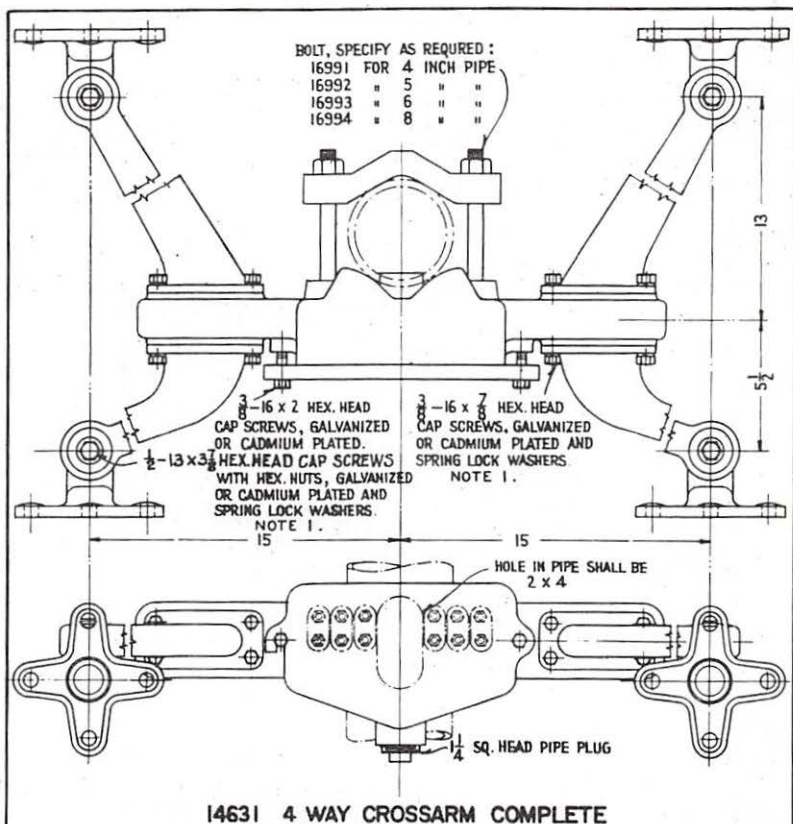
(d) Circuits shall be so arranged that a failure of the gate mechanism to operate as intended will not prevent the lights on gate arm and signal from operating on the approach of a train.

(e) Bell, when used, shall sound a warning from the time the signal lights start to operate at least until the gate arm has descended to within 10 deg. of the horizontal position.

6. Controls for "No Right Turn" and "No Left Turn" Signals.

(a) Sign shall be illuminated without flashing during period that the crossing signals are operating.

(b) The marker light located above the sign shall flash in synchronism with the crossing signals.



NOTE 1: GALVANIZING OR CADMIUM PLATING
SPECIFIED SHALL BE DONE AFTER
THREADS HAVE BEEN CUT.

0 1 2 3 6 9 12
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

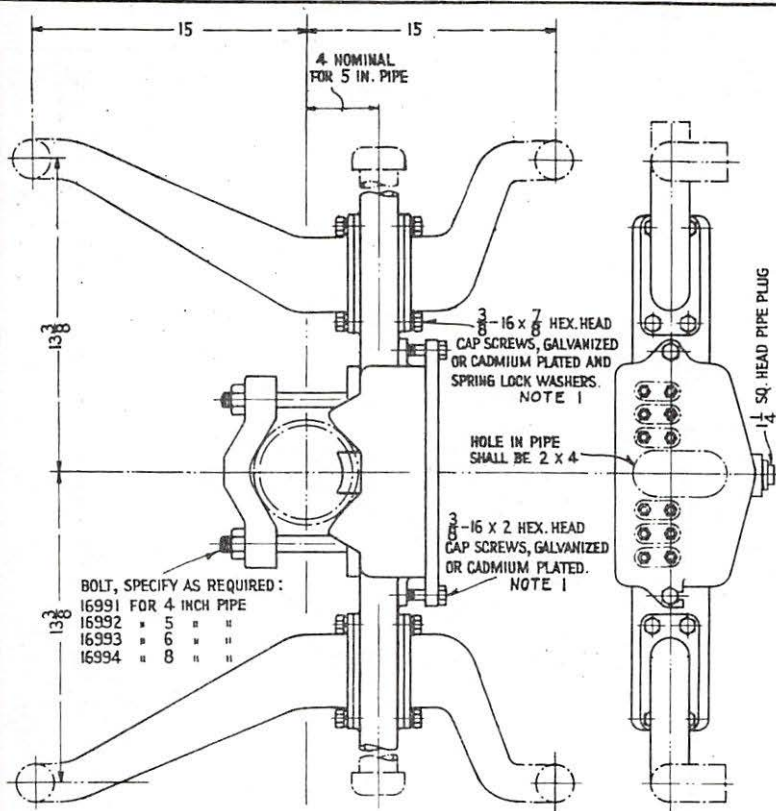
CROSSARM FOR EXTENDED LIGHTS

FOR FLASHING LIGHT HIGHWAY CROSSING SIGNAL WITH PEDESTAL MOUNTED GATE - ASSEMBLY

AAR
SIGNAL
1463C

OCT 1967 SEP 1952 SEP 1950

Bolts, nuts and threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17; Spring lock washers shall be of carbon steel (USA current Specification B27. 1 is preferred, where practicable).



14681 4 WAY CROSSARM COMPL., THREADED TYPE ELBOW AND CAP
14682 " " " " CLAMP " " " "

ELBOW DESIGNED FOR VERTICAL AND HORIZONTAL ADJUSTMENT OF ELECTRIC
LIGHT UNIT AND FREE FROM MOISTURE LEAKAGE.

MATERIAL: CAST IRON OR ALUMINUM

NOTE 1: GALVANIZING OR CADMIUM PLATING SPECIFIED SHALL
BE DONE AFTER THREADS HAVE BEEN CUT.

0 1 2 3 6 9
SCALE AND ALL DIMENSIONS
GIVEN IN INCHES

CROSSARM FOR SUSPENDED LIGHTS
 FOR FLASHING LIGHT HIGHWAY CROSSING SIGNAL WITH MAST MOUNTED GATE - ASSEMBLIES

AAR
SIGNAL
1468C

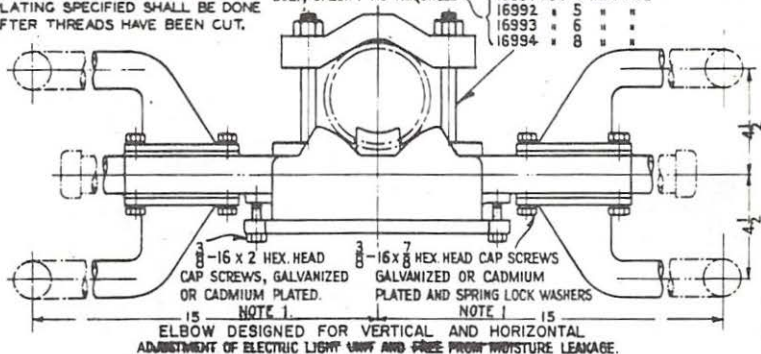
OCT. 1967 SEP. 1952

Cast iron shall be Class 20 in accordance with Specifications for Gray Iron Castings, Manual Part 88; Threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17; Cast aluminum shall be in accordance with ASTM current Specification B26, alloy number and treatment as required. When practicable, the surface treatment shall be corrosion inhibiting type. Painting, when required, shall conform to Instructions for Painting, Manual Part 110.

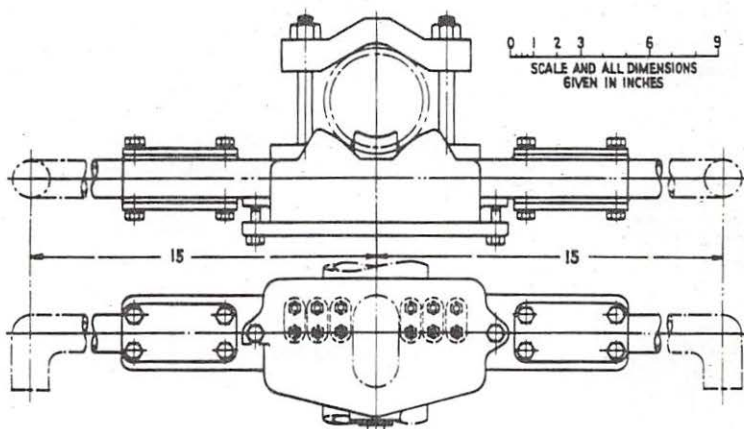
NOTE 1: GALVANIZING OR CADMIUM PLATING SPECIFIED SHALL BE DONE AFTER THREADS HAVE BEEN CUT.

BOLT, SPECIFY AS REQUIRED.

16991 FOR 4 INCH PIPE
16992 " 5 " "
16993 " 6 " "
16994 " 8 " "



16565 4 WAY CROSSARM COMPL., MATERIAL: CAST IRON OR ALUMINUM.



16567 2 WAY CROSSARM COMPL., MATERIAL: CAST IRON OR ALUMINUM.

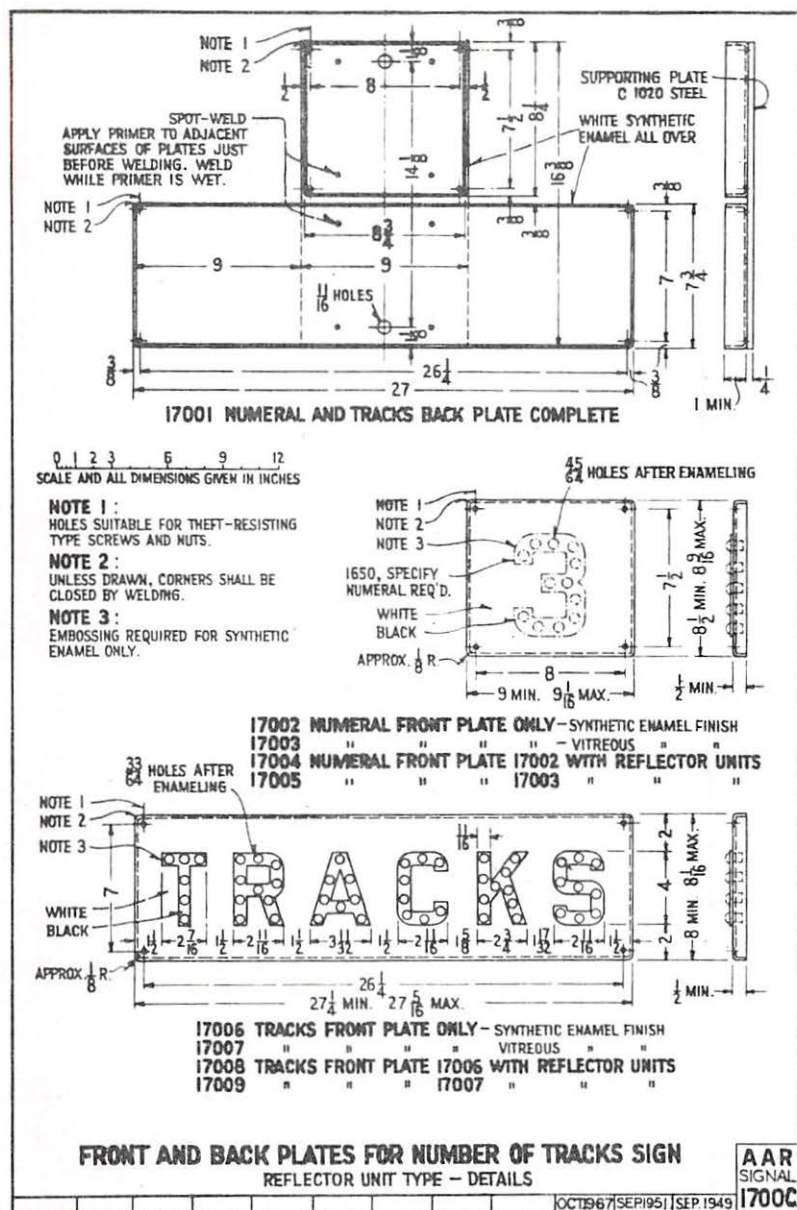
CROSSARM FOR SUSPENDED LIGHTS

FOR FLASHING LIGHT HIGHWAY CROSSING SIGNALS WITHOUT GATES - 4 TO 8 INCH PIPE - ASSEMBLIES

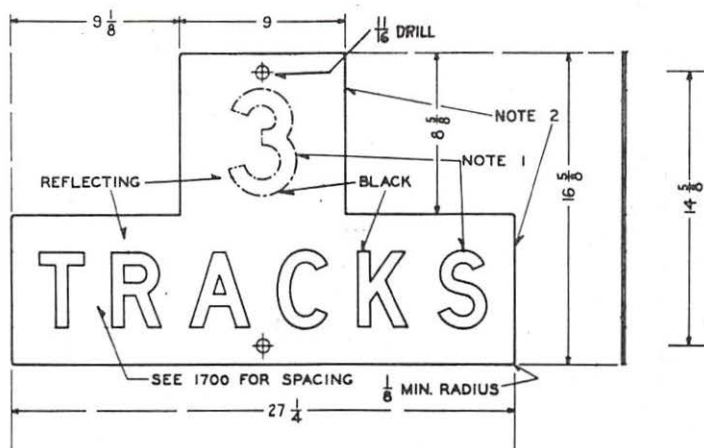
**AAR
SIGNAL
1656F**

Cast iron shall be Class 20 in accordance with Specifications for Gray Iron Castings, Manual Part 88; Threads shall be in accordance with Specifications for Bolts, Nuts and Threads, Manual Part 17; Cast aluminum shall be in accordance with ASTM current Specification B26, alloy number and treatment as required. When practicable, the surface treatment shall be corrosion inhibiting type. Painting, when required, shall conform to Instructions for Painting, Manual Part 110.

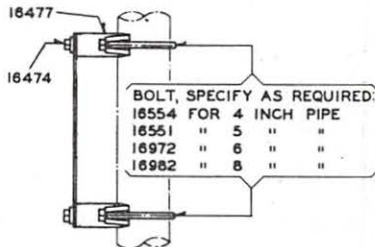
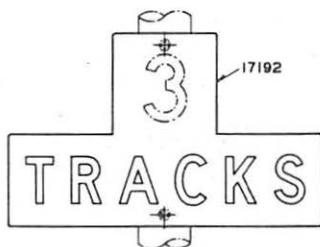
OCT 1967 SEP 1952 SEP 1949 SEP 1947 MAR 1936 MAR 1935



Material and painting shall be in accordance with Manual Parts 43 and 44.



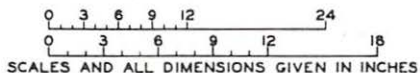
17192 NUMBER OF TRACKS PLATE. SPECIFY NUMERAL



17191 NUMBER OF TRACKS SIGN COMPL. SPECIFY NUMERAL AND PIPE SIZE

NOTE 1: SEE 1713 AND 1714 FOR DETAILS.

NOTE 2: SIGN MAY BE MADE OF 9 IN. EXTRUDED ALUMINUM SECTIONS.

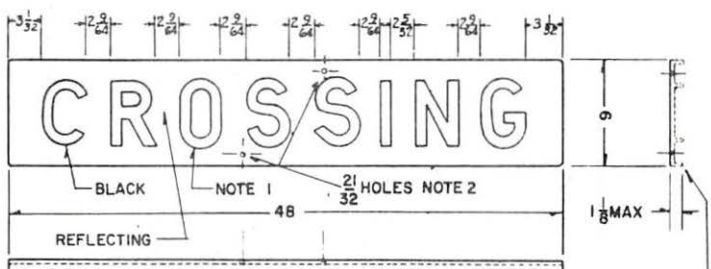


NUMBER OF TRACKS SIGN

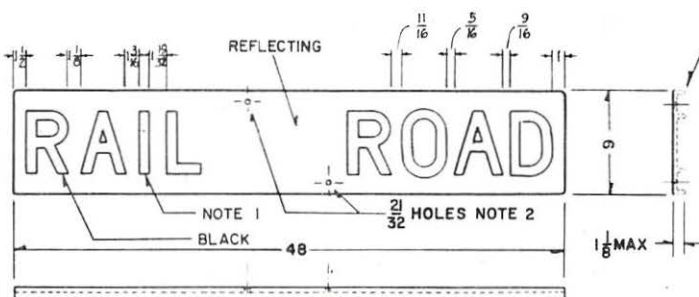
REFLEX-REFLECTING SHEET TYPE FOR 4 TO 8 INCH PIPE - DETAIL AND ASSEMBLY

AAR
SIGNAL
1719C

OCT. 1967 SEP. 1946 SEP. 1951



17271 CROSSING PLATE EXTRUDED ALUMINUM



17272 RAILROAD PLATE EXTRUDED ALUMINUM

NOTES:

1. SEE 1712 FOR DETAILS
2. SPACING AS REQUIRED BY EXTRUSION.

0 3 6 9 12
SCALE AND ALL DIMENSIONS GIVEN IN INCHES

PLATES FOR 90°RAILROAD CROSSING SIGN

EXTRUDED ALUMINUM
REFLEX - REFLECTING SHEET TYPE — DETAILS

AAR
SIGNAL

OCT 1957 OCT 1959

1727B

Exhibit 8-C

ANNUAL COST OF AUTOMATIC HIGHWAY GRADE
CROSSING PROTECTION DEVICES EXCLUSIVE
OF INSTALLATION COSTS

In 1961, Committee 8 computed the annual average cost of maintaining flashing light signals, and flashing light signals with automatic gates, from cost data supplied by 30 railroads covering 73 installations.

To keep this annual cost in relation to current prices, the committee developed an empirical formula based on Interstate Commerce Commission Indices for Account 27, for the applicable geographical region

Annual Cost of Flashing Signals where \$581 is the base figure for 1961 = $581 \times \frac{Y}{X}$

Flashing Signals with Gates = $\$1099 \times \frac{Y}{X}$

Y is the ICC index for the year under consideration, X is the ICC index for the year 1961.

Since Committee 8 feels that this subject is worthy of reissue, as information, and in order to further clarify the original report, the committee would like to point out that these indices are readily available from any individual railroad's valuation department.

Exhibit 8-D

METHOD TO IMPROVE EFFECTIVENESS OF
RAILROAD-HIGHWAY GRADE CROSSING PROTECTION

A Western Railroad was experiencing difficulty at a railroad-highway grade crossing, which had a main line track, a running track and four yard tracks (see Fig. 1). The crossing is protected by a flashing light type grade crossing device, using conventional d-c track circuits. Main line movements over this crossing average 15 to 20 trains per day. There are also many switching movements on Tracks 1 to 5. Cars are stored on the yard track adjacent to the crossing.

In order to improve the conditions at this crossing, two changes were made:

1. Clearance signs stating "KEEP TRACKS CLEAR HERE TO CROSSING" were installed approximately 150 ft. east and west of the crossing (see Fig. 1).
2. A Rotating Beacon Ray (Gyalite) Indicator was located in the southeast quadrant of the crossing on a 22-ft. mast (see Fig. 2).

Train movements, other than through movements on the main track or Track 1, are restricted from entering the crossing until the indicator has commenced to operate. This indicator is interconnected with the signal system, so that the flashing light type highway crossing signals will operate for a minimum of 20 seconds before the indicator is permitted to operate.

When the signs and indicator were installed, the following bulletin was issued:

"Effective _____ A. M. _____, a flashing lunar white indicator will be placed in service at Avenue North. This indicator is located in the southeast quadrant of the crossing on a 22-ft. mast. Train movements other than through movements on the main track will be restricted from entering this crossing until this flashing lunar white indicator has commenced to operate.

"This indicator is interconnected with the signal system so that the flashing light highway crossing signals will have to operate for a minimum of 20 seconds before the lunar indicator is permitted to operate.

"Trains or engines using Tracks 2 to 5, inclusive, will approach the crossing until they are on the crossing signal starting circuit. After the flashing lunar indicator commences to operate, they may proceed over the crossing."

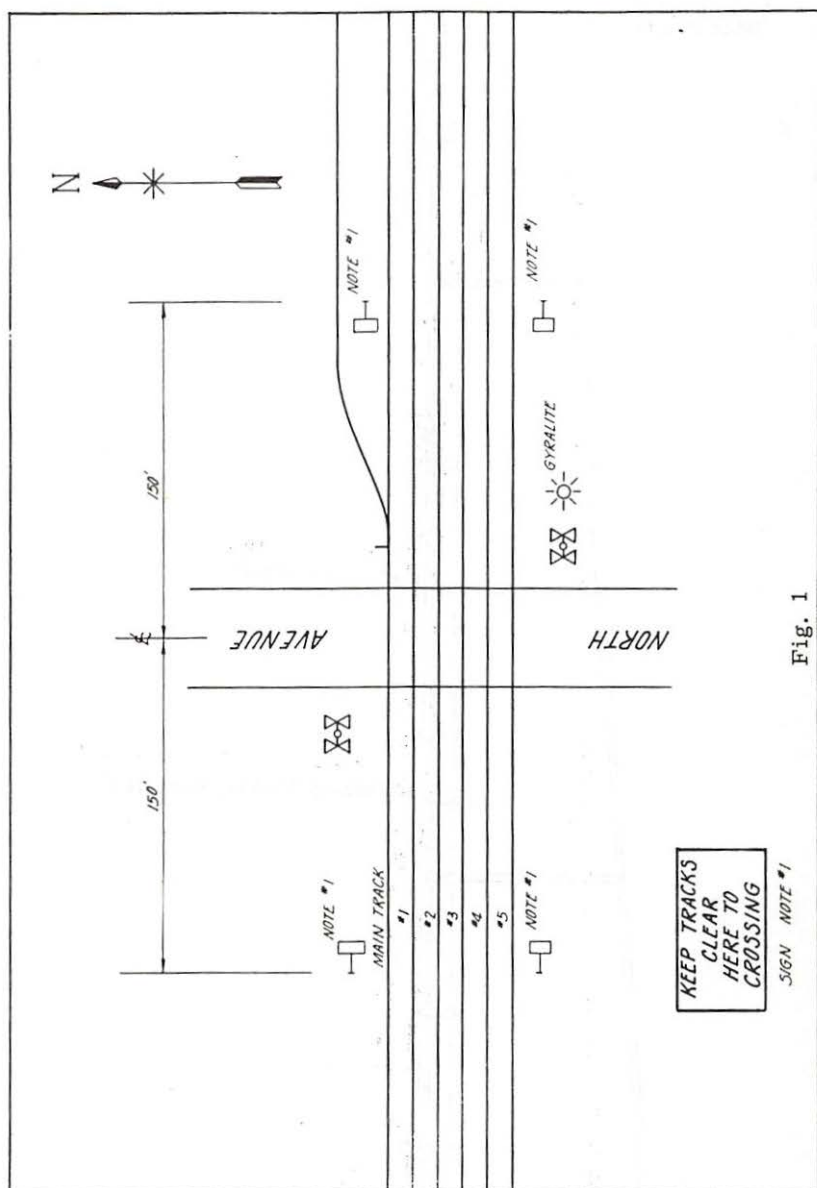


Fig. 1

BLOCK OUT OBJECTIONABLE LIGHT
AREA BY PAINTING PORTION OF
INSIDE OF GLASS DOME.

ROTATING BEACON RAY

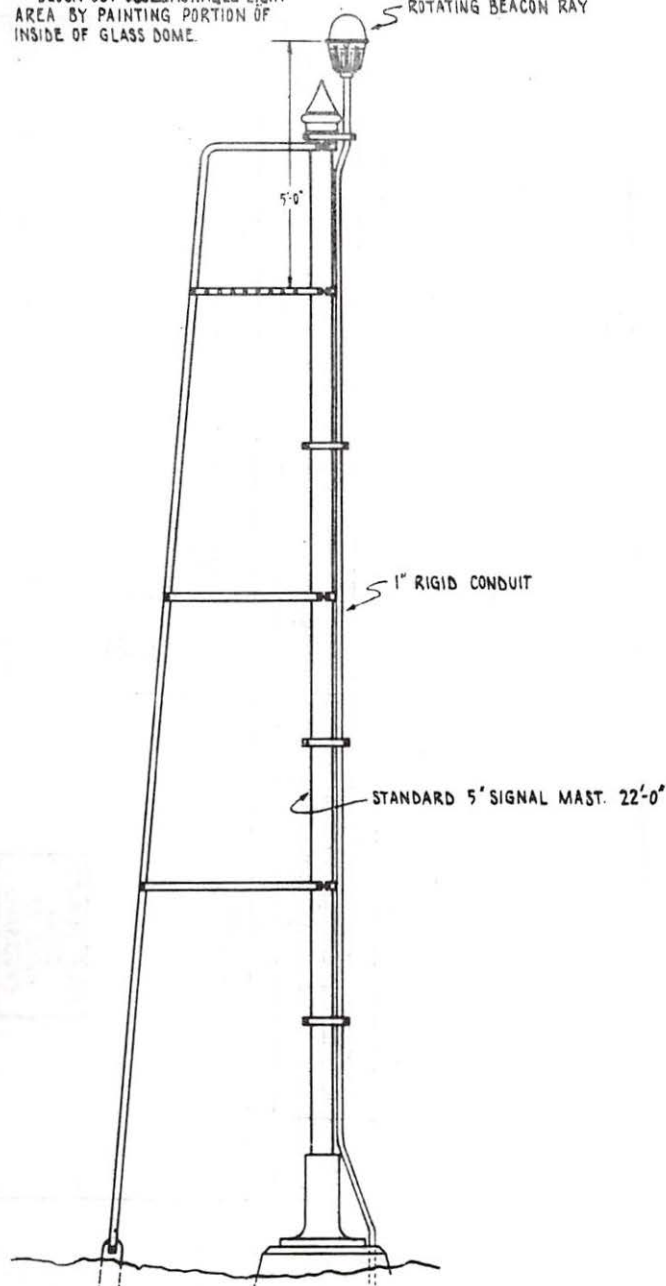


Fig. 2

At crossing signal installations where special circuits are provided to protect train movements other than through movements, the degree of success depends upon the compliance with operating instructions. Track circuits on Tracks 2 to 5 extend approximately 100 ft. each side of the street and afford positive operation when occupied. Compliance with the instructions insures adequate warning time to the motoring public.

Main Line train movements and movements on the running track are protected by circuits that afford 20-second warning for the fastest moves over the crossing.

Exhibit 8-E

INTERCONNECTION OF HIGHWAY GRADE CROSSING
PROTECTION DEVICES WITH STREET TRAFFIC SIGNALS

An interesting and complex problem in traffic signal preemption was encountered recently when a State Regulatory Commission ordered the installation of automatic gates at crossings involving parallel main lines and yard tracks to two railroads. Physical layout of the crossings and an adjacent street intersection is shown in Fig. 1. The following daily traffic volumes will give an indication of the amount of conflict occurring.

Vehicular Traffic

Ave. N = 10, 200

Ave. W = 30, 000

Rail Movements

Railroad A = 15-20 (20 mph)

Railroad B = 45-50 (35 mph)

Preliminary observations at the site convinced the Signal Departments of both railroads that something more elaborate than the usual traffic signal interconnection would be required to clear the track areas in advance of approaching trains and allow proper operation of the crossing gates. As shown in Fig. 1, there is a distance of 340 ft., or space for approximately 17 northbound cars per land, between the first gate (4) and the edge of the street intersection. Clear space between the tracks of the two railroads available for vehicular storage measures approximately 140 ft., good for about seven cars per lane. There is also storage space available for two or three cars per lane between the tracks of Railroad A and the intersection.

Because of the extremely heavy traffic on Avenue W, the intersection signals had been set to favor this street with a 45 second-15 second cycle. City traffic engineers were insistent that this disparity be maintained to avoid slowing down the heavy volume on this important artery. Time-distance traffic flow charts were prepared, indicating that an average of five northbound vehicles would pass through the intersection on each cycle with the setting in effect. Observations on the ground showed that it was a very common occurrence to have the entire area over both railroads filled continuously with northbound vehicles held up by the traffic signals and these also bore out the findings of the time-distance charts with regard to the movement of Avenue N traffic through the intersection. It was noted that during peak periods a northbound vehicle usually entered the intersection in the third cycle after it passed Gate 4 of Railroad B.

Final determination was that an advance preemption of 60 seconds would be required to clear the tracks before arrival of a train at the crossing. In order to provide for simultaneous moves on each railroad, the following sequence of operation has been devised:

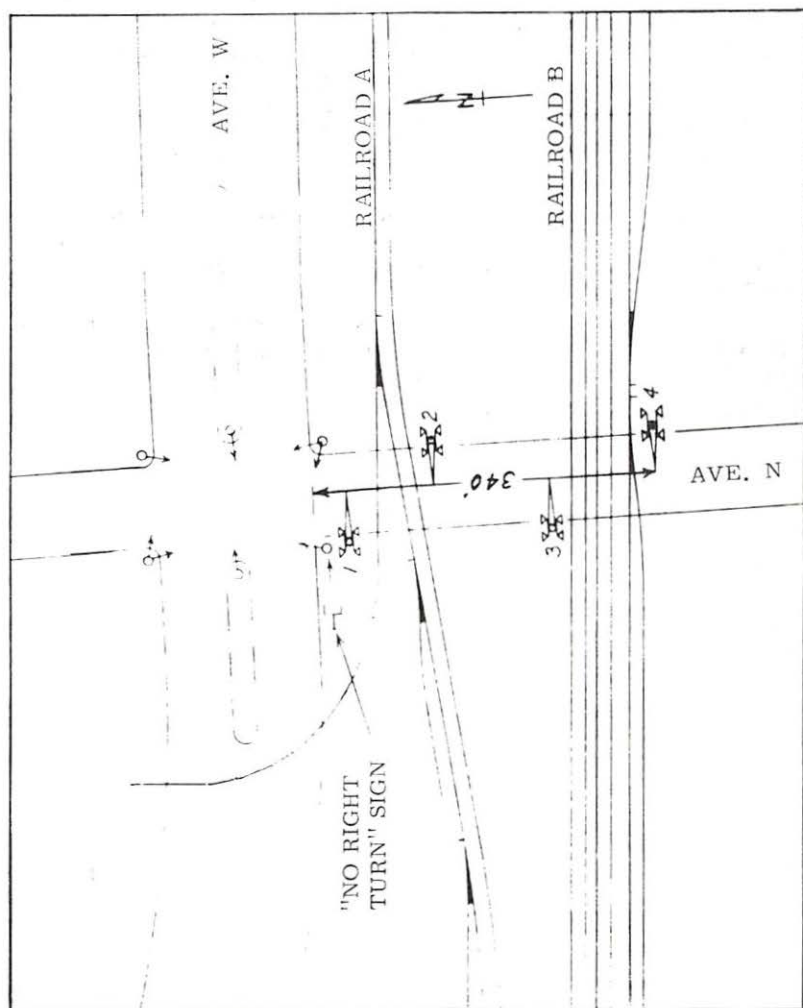


Fig. 1

1. Sixty seconds before arrival of a train on either railroad, Gate 4 will actuate and all traffic signals, except those governing northbound vehicles on Avenue N, will display a solid red aspect after phasing through necessary amber prewarning. The latter will display green aspect. Train actuated "No Right Turn" sign will also illuminate to keep turning vehicles from entering the track area. Back lights on Gate 4 and the balance of the crossing signals remain inoperative during this period to allow vehicles to clear the track area of Railroad B.

2. Thirty seconds before arrival of a train:

- (a) On Railroad A - Gates 1 and 2 will actuate.
- (b) On Railroad B - Gates 1 and 3 will actuate.

Traffic signals will retain their preemption aspects through the entire 60-second period before arrival of a train and will then display a permissive aspect for traffic on Avenue W.

It is anticipated that the time afforded free movement of traffic along Avenue W during the passage of the train over the crossing will compensate for the delay during preemption and that overall effect on this traffic artery will be minimal.

Exhibit 8-F

STATE ACTIVITIES RELATING TO
CROSSING PROTECTION

The Corporation Commission, State of Oklahoma, has issued a railroad signal order covering rules and regulations to regulate the installation, inspection and testing of flasher and other warning signals at railroad crossings. In general, the specifications for the installation, maintenance, inspection and testing of protective devices make the following provisions:

"1. Protective devices of the flashing light type (with or without gates), installed by railway companies subject to the jurisdiction of the Commission, pursuant to an order of the Commission, shall comply with the specifications and generally recognized national standards as prescribed and promulgated by the Association of American Railroads unless specifically otherwise provided herein for protective devices of the flashing light type, and shall be maintained, inspected and tested in accordance with the same procedures.

"2. Any railroad-highway grade crossing at which warning signs, signals or protective devices are installed, or are to be installed, pursuant to an order of the Oklahoma Corporation Commission shall be considered to be a crossing governed by the provisions of Title 17, Sections 86 and 87, Oklahoma Statutes.

"3. Unless otherwise ordered by the Commission, protective devices installed prior to the effective date of these specifications are not required to conform with the specifications herein but such protective devices shall be maintained and tested in accordance with the Commission's rules.

"4. Carrier shall within sixty (60) days from the effective date of these rules, file with the Commission in duplicate, appropriate lists, from which all such crossings in the State of Oklahoma may be identified or located."

These Rules and Regulations became effective April 1, 1966.

* * * * *

Also, the State of Louisiana has enacted a law, Section 387, which provides that:

"The Department of Highways may, to the extent that the Legislature appropriates funds therefor, make payments to railroads, whose railroad grade crossings across state highways are or shall hereafter be marked by the installation of flashing light signals, for no more than one-half the cost of maintenance of such flashing light signals during the fiscal year for which the funds are appropriated."

* * * * *

When outside parties participate in the maintenance expense of highway crossing signal facilities, it is desirable that payment be on an annual weighted average basis. It is important that covering agreements permit periodic adjustments in the fixed costs agreed upon.

Recently, a Southeastern State, which shares maintenance costs of highway crossing signals equally with the railroads, granted an increase of approximately 23 percent to cover increased maintenance expenses to the railroads.

Exhibit 8-G

STATUS OF STOP ON RED SIGNAL SIGN IN VARIOUS STATES

States which have given permission to remove sign:

Alabama	Maine	North Carolina
Arkansas	Massachusetts	Ohio
California	Minnesota	Oklahoma
Colorado	Mississippi	South Carolina
Delaware	Missouri	Tennessee
Florida	Montana	Texas
Georgia	Nebraska	Utah
Illinois	Nevada	Virginia
Indiana	New Hampshire (on	Washington
Kansas	auto. gates only)	West Virginia
Kentucky	New Jersey	Wisconsin
Louisiana	New Mexico	

States which have not given permission to remove sign:

Connecticut
Iowa
Maryland
Michigan

States which have not yet decided to remove sign:

New York
Vermont

States on which no report has been received:

Arizona
Idaho
North Dakota
Oregon
Pennsylvania
Rhode Island
South Dakota
Wyoming

REPORT OF
COMMITTEE 9--TRANSMISSION

- J. M. Hesser (Chairman), Asst. Mgr. Sigs. & Comms., Norfolk & Western Ry.
R. A. Hicks, Jr. (Vice Chairman), Asst. to Engr. of Comms., Louisville & Nashville R.R.
N. V. Butkovich, Electronics Engr., Chicago & North Western Ry.
S. W. Clark, Comms. Engr., Missouri Pacific R.R.
K. H. Corajod, Engr. of Radio Comms., Illinois Central R.R.
P. A. Flanagan, Engr. Comms. & Sigs., Chesapeake & Ohio Ry.
R. N. Hettrick, Comms. Engr., Chicago, Milwaukee, St. Paul & Pacific R.R.
C. O. Jett, Supt. Comms., Union Pacific R.R.
G. W. Kearney, Comms. Engr. - Sys., Baltimore & Ohio R.R.
J. L. Nash, Asst. to Regl. Engr. Sigs. & Comms., Norfolk & Western Ry.
L. J. Ritter, Staff Engr. - Comms. & Sigs., New York Central R.R.
J. L. Smith, Insptr. Comms., Pennsylvania R.R.
C. G. Webster, Sys. Planning Engr., Telecomms. Dept., Canadian National Rys.

Consulting Members

- R. L. Berube, Adm. Asst. to Dir. of Engrg., Kleinschmidt Div. of Smith-Corona Marchant, Inc.
G. W. Brown, Comm. & Data Systems Div., Collins Radio Co.
R. H. Fish, Prod. Mgr. - Data, Telegraph & Supervisory Control Engrg., Lenkurt Electric Co., Inc.
R. T. Gordon, Mgr., Data Requisitions Engrg., General Electric Co.
H. C. Likel, Sr. Engr., Transmission Systems Div., The Western Union Telegraph Co.
A. F. Perkins, Chf. of Transmission Engrg., Stromberg-Carlson Corp.
J. N. Petrie, Chf. Transmission Engr., Automatic Electric Co.

July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Investigate and report on preferred methods and devices for measurement of data transmission through data sets in the following ranges:
 - (a) 0 to 200 bits per second.
 - (b) 200 to 2400 bits per second.
 - (c) 2400 to 4800 bits per second.
 - (d) Above 4800 bits per second.(Under (b), (c) and (d), measurements for transmission frequency response, delay distortion, and steady and impulse noise should be included.)
4. Investigate and report on operating characteristics of:
 - (a) Popular digital data modems.
 - (b) Popular analog modems.(Reports on (a) and (b) should include the following:
 1. Usable receiving level/maximum transmit level.
 2. Level stability (long and short term).
 3. Frequency stability (long and short term).
 4. Transmission frequency response.
 5. Noise: Steady and impulse.
 6. Delay distortion.)
5. Investigate and report on new design criteria for switch networks:
 - (a) Two-wire versus four-wire switching.
 - (b) Application of compandors.
 - (c) Signaling problems associated with two-wire and four-wire switching systems (in-band and out-of-band).
 - (d) Automatic control versus user controlled alternate routing.
 - (e) Tone-off--Tone-on.
 - (f) Speech plus duplex.
 - (g) Converter circuits to permit different types of signal systems to be interconnected on a d-c basis.
 - (h) Accepted pulse ratio.
 - (i) Location of compandors on circuits equipped with in-band single frequency signaling units, also application on speech plus carrier circuits equipped with FM telegraph.
 - (j) Idle line termination under control of called party.
 - (k) Remote control disconnects.

6. Investigate and report on progress in error detection and correction systems.
7. Investigate and report on progress in the development of a standard interface to be used for interchange of data between railroads.
10. Investigate and report on those railroads using, and the application being made, of electronic switching (computers) operations for message and data traffic.
11. Investigate and report on techniques for expanding dispatchers circuits on a four-wire basis to interconnect with physical circuits, single, three-way, four-way and multiple.
12. Investigate and report on disturbances to railroad communications from Extra High Voltage Power Transmission line.

The committee submits for consideration, reports on the following subjects:

- 3 (d). New Model Envelope Delay Test Set, as Exhibit 9-A, page 218.

Action Recommended

Acceptance as information.

4. Data Modem Characteristics. This information, which is a supplement to folded tabulation sheet appearing as Exhibit 9-A, page 224-A, in the 1965 Advance Reports, is being printed on 8 1/2 in. by 11 in. sheets and is available from the Secretary's office upon request.

Action Recommended

Acceptance as information.

- 5 (a). Fundamental Transmission Principles of Two-Wire and Four-Wire Switching, as Exhibit 9-B, page 219.

Action Recommended

Acceptance as information.

- 5 (f). Speech-Plus-Duplex Operations Over Telephone Trunk Circuits, as Exhibit 9-C, page 235.

Action Recommended

Acceptance as information.

5 (g). Converter Circuits to Permit Different Types of Signal Systems to be Interconnected on a D-C Basis, as Exhibit 9-D, page 240.

Action Recommended

Acceptance as information.

10. Characteristics of Computerized Message Switching Centers Placed in Service on Railroads Since January 1, 1966, as Exhibit 9-E, page 247. This report on two new switching centers is supplemental to report appearing as Exhibit 9-E, page 296, in the 1966 Advance Reports.

Action Recommended

Acceptance as information.

12. High Voltage Direct Current Transmission, as Exhibit 9-F, page 249.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 9--TRANSMISSION

Exhibit 9-A

NEW MODEL ENVELOPE DELAY TEST SET

A new model envelope delay test set is available with the following characteristics:

1. Direct digital readout of delay in microseconds with resolution of 0.1 microsecond.
2. Single delay range from - 20,000 microseconds to + 20,000 microseconds (25-Hz modulation) or - 2000 to + 2000 microseconds (250-Hz modulation).
3. Direct digital readout of frequency to nearest 10 Hz.
4. Covers 300 Hz to 110 kHz, for both voice and group frequencies of CCITT and Western Electric carrier multiplex systems.
5. Precision internal master clock permits accurate end-to-end delay measurements without separate reference circuit.
6. Built-in 1-MHz frequency counter with 1-Hz accuracy allows counter operation with signal levels as low as - 45 dbm.

Signals may be inserted at the voice frequency side of a carrier channel and delay characteristics measured at the channel bank output. By reversing the procedure, the characteristics of the receive side of the channel can be measured.

Exhibit 9-B

FUNDAMENTAL TRANSMISSION PRINCIPLES OF
TWO-WIRE AND FOUR-WIRE SWITCHING

Introduction to Telephone Network Switching Philosophy.

The commercial telephone companies have developed a nationwide switching plan that provides for routing telephone traffic automatically to its destination. This switching plan takes full advantage of the overall economies offered by the alternate routing capabilities of automatic switching systems to rapidly select a number of different alternate routes when "no circuit" conditions prevail on the direct or "high usage" route. Trunk plant is used more efficiently under this method than would be possible under manual operation, and operators are required only for handling of special services.

Large volumes of traffic between any two points are generally routed most economically over direct trunks. When the volume of traffic between two offices is small, the use of direct trunks is usually not economical. In these cases, the traffic is handled by connecting together, by means of switching equipment at intermediate offices, two or more trunks to build up the required connection.

"Built-up" connections may involve several intermediate switching offices if the originating and terminating locations are a great distance apart and the traffic volume is small.

Under the switching plan, each intermediate switching office is classified and designated according to its switching function, its interrelationship with other switching offices, and its transmission requirements. The class designations given to the switching offices in the network determine the routing pattern for all calls.

Figure 1 illustrates how various classes of offices might be grouped.

Offices where local telephone circuits are terminated for purposes of interconnection to each other are called "local," "end" or "Class 5" offices.

Switching points where trunks from Class 5 offices are connected to the nationwide network are called "Toll Centers" (or "Toll Points") and are designated as "Class 4" offices.

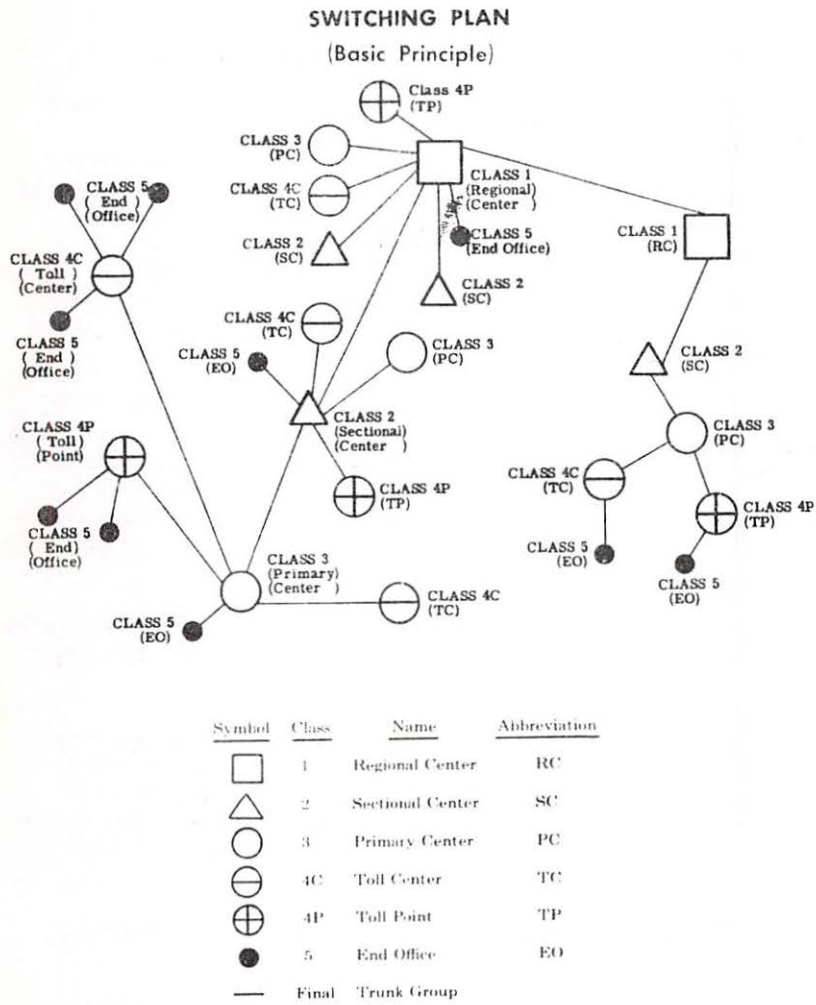


Fig. 1

Certain offices, in addition to connecting end offices to the network, are selected to serve as higher ranking switching points. These are "Primary Centers," designated "Class 3"; "Sectional Centers," designated "Class 2"; and "Regional Centers," designated "Class 1."

Collectively, the Class 1, 2 and 3 offices constitute the switching points at which built-up connections are established; that is, "intermediate trunks" are connected to other "intermediate trunks."

Figure 2 shows the typical backbone network of "final" trunk groups interconnecting the several classes of offices. One final trunk group is always provided from each office to an office of higher rank.

The systematic grouping of switching offices results in a similar grouping of the areas they serve. Each Regional Center serves a large area known as a Region. Each Region is subdivided into smaller areas known as sections, with its principal switching office designated as a Sectional Center.

Sections are further subdivided into smaller parts known as Primary areas served by a Primary Center. The remaining switching centers are the Toll Centers (and Toll Points) and End Offices.

It should be noted that End Offices (Class 5) are connected to any higher class office such as Class 4, 3, 2 or 1. In a similar manner, Toll Centers (Class 4) may be connected to any higher class office such as Class 3, 2 or 1. Primary Centers (Class 3) may be connected to any higher class office such as Class 2 or 1. Sectional Centers (Class 2) may be connected only to Regional Centers (Class 1). Regional Centers will be connected by direct trunks to other Regional Centers.

All trunks interconnecting Class 1, 2, 3 and 4 offices will usually consist of four-wire facilities. Substantial transmission advantages are obtained if these four-wire trunk facilities are switched together on a four-wire basis. Alternatively, equipping these trunk facilities with four-wire terminating sets and then switching them on a two-wire basis will create a number of problems due to echo, singing and instability of levels.

The local telephone line will always consist of two-wire facilities; therefore, it is only logical to switch it on a two-wire basis.

Transmission Design Objectives	
Final Route Trunks	Average Office Balance Requirements for 2 Wire Switching of VNL Trunk to VNL Trunk (Average return loss db)

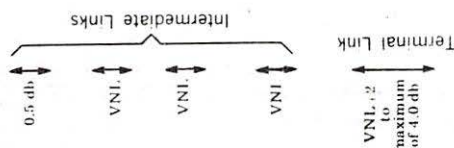
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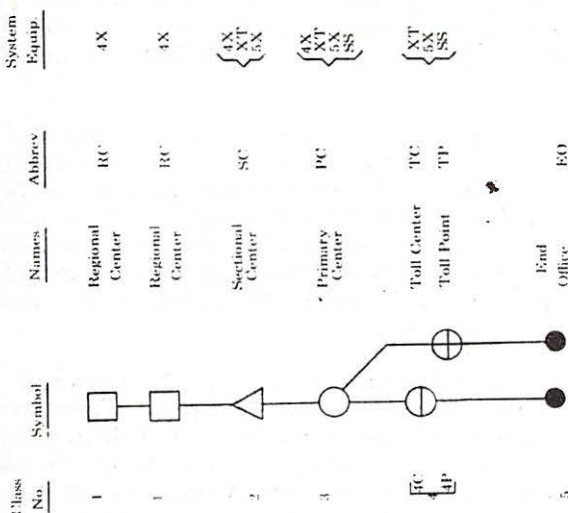
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Notes 1 & 2



- Note: 1. No Through Switching Requirement.
2. 15 db balance to the average distribution of local loops in the class 5 office. For measurement purposes, a 900-ohm test termination is used in the class 5 office. The specific measured return loss requirement is a function of the type facility used for trunks to the end office.



1X-4A or 4M Crossbar
XT-Crossbar Tandem
5X-No. 5 Crossbar
SS-Step-by-Step

* Equipment Manufactured by Independent Suppliers with equivalent features may also be used.

Fig. 2

The trunks from the local (Class 5) office to the Class 4 office usually will also consist of two-wire facilities, especially if the Class 5 and Class 4 offices are located in the same building or close together.

At some point in the built-up connection, it becomes necessary to interconnect these two-wire circuits with the four-wire circuits extending to the higher class offices.

Usually, the four-wire terminating set used for accomplishing this conversion will be associated with the intermediate trunks terminating in the Toll Center offices. This requires that the actual switching of the intermediate trunk to the terminal trunk will be on a two-wire basis. Under some conditions, at higher class offices where four-wire switching is used on through connections, it will be advantageous to permanently associate a four-wire terminating set with each of the terminating trunks. This requires that the actual switching of the intermediate trunk to the terminating trunk will be on a four-wire basis. This arrangement would apply also in those situations where a Class 3 (or higher) and a Class 5 office are located very close together (or in the same building) and the Class 3 switching is done on a four-wire basis while the Class 5 office switching, on the two-wire side of the terminating set, is done on a two-wire basis.

If you were starting now to build the telephone network that serves the North American continent, you would probably use four-wire network facilities throughout, with four-wire switching. Such a network would be inherently stable, and could be operated at substantially zero loss on each trunk, so that no matter how many trunks might be tandemed to establish a connection, transmission would not be affected. This ideal situation has recently been attained in some switched networks, both military and private, when it was possible to build them "from scratch." But it is not economically attainable in the existing network, which already has a large two-wire trunk plant and in which the great majority of switchboards are of the two-wire type, not to mention the fantastic size of the two-wire local loop plant with its two-wire telephones. The best we can hope to do, in the foreseeable future, is to apply four-wire switching in those situations where its beneficial effects will be so great as to justify its additional cost.

There are not many such situations in the Independent Telephone companies at this time. Their exchanges, principally Class

4 and Class 5, are connected by two-wire trunks, and nothing could be gained by introducing four-wire switching. In fact, the four-wire terminating sets that would then be required would introduce problems of their own, as we shall see.

There are, however, a few Class 3 offices among the Independents; some or all of these, from a technical point of view, could advantageously be switched on a four-wire basis. Furthermore, Independent companies may be called upon to provide four-wire switching and facilities for private-line switched networks that must meet the same stringent requirements as the Direct Distance Dialing network. From the point of view of the ultimate user, satisfactory performance of a communication system is essentially a matter of obtaining acceptable transmission of intelligence from the speaker to the listener. Usually, the main criterion applied by the user is one of the "loudness" with which he can hear the other speaker. This implies circuits having the lowest practical losses. This report will therefore discuss the transmission improvement that can be achieved by using four-wire switching, and the problems (not the least of which is cost) that might make it advisable in specific cases.

Philosophy of Direct Distance Dialing.

Under the Direct Distance Dialing (DDD) plan, a large part of the total traffic is handled over direct trunks, with a minimum of switching. Nevertheless, on some calls within the North American continent, from two to ten trunks may be connected in tandem (including the trunk between the calling party's local exchange and the first toll switching center as well as the trunk between the last toll switching center and the called telephone). As a result of the alternate-routing capabilities of DDD, successive calls involving the same two telephones may encounter a different number of trunks, over different facilities between the first and last switching center.

The implications are that the transmission loss of each trunk between toll switching centers must be kept low in order to provide adequate transmission on all calls and to avoid large differences in transmission performance on successive calls between the same two telephones.

Design of Trunks.

Today, almost all trunk circuits over 20 miles in length are derived by some one of the several multiplexing techniques. The two resulting separate voice channels are usually referred to as an

"equivalent four-wire circuit" or simply a "four-wire circuit," one channel in the A-B direction and the other in the B-A direction. Four-wire circuits are inherently stable and can be operated at substantially zero attenuation regardless of their length. It is practical and frequently necessary to connect several four-wire circuits together in tandem for long built-up circuits, or switch them together at "four-wire" switching offices.

Four-wire circuits will usually be switched together on a four-wire basis at intermediate switching centers to establish the longer through connections, and if they retain their four-wire nature at these intermediate switching centers, almost any number of separate links may be connected in tandem with no adverse effects, because each direction of transmission will be separate from the other.

In contrast, most of the end-link trunks and almost all of the subscriber's local circuits consist of two-wire circuits, in which the same path is used for both directions of transmission. It follows that "four-wire terminating sets" will have to be inserted in at least two locations between the two-wire and four-wire facilities of a typical long-distance telephone connection, even if at several of the intermediate switching centers the four-wire circuits are connected through on a four-wire basis.

Major Considerations in Trunk Design.

In designing the telephone trunk circuits to achieve the lowest practical net losses, at least the following considerations will be important:

1. Echo delay.
2. Echo return loss (ERL).
3. The talker's tolerance to echo.
4. Circuit stability against "singing."

Other factors, such as absolute delay, crosstalk, transmission bandwidth, and amplitude distortion, enter into the situation but have only an indirect bearing on the net loss (attenuation) at which a circuit can be operated.

Echo Delay.

Echo can cause definite transmission impairment. It causes circuit "hollowness" because of the delay between the direct and reflected signals and is disturbing to the talker because it gives him the impression that the listener is trying to interrupt. ("Listener echo," although it encounters an even greater delay, is usually not a problem because it encounters sufficient additional attenuation.)

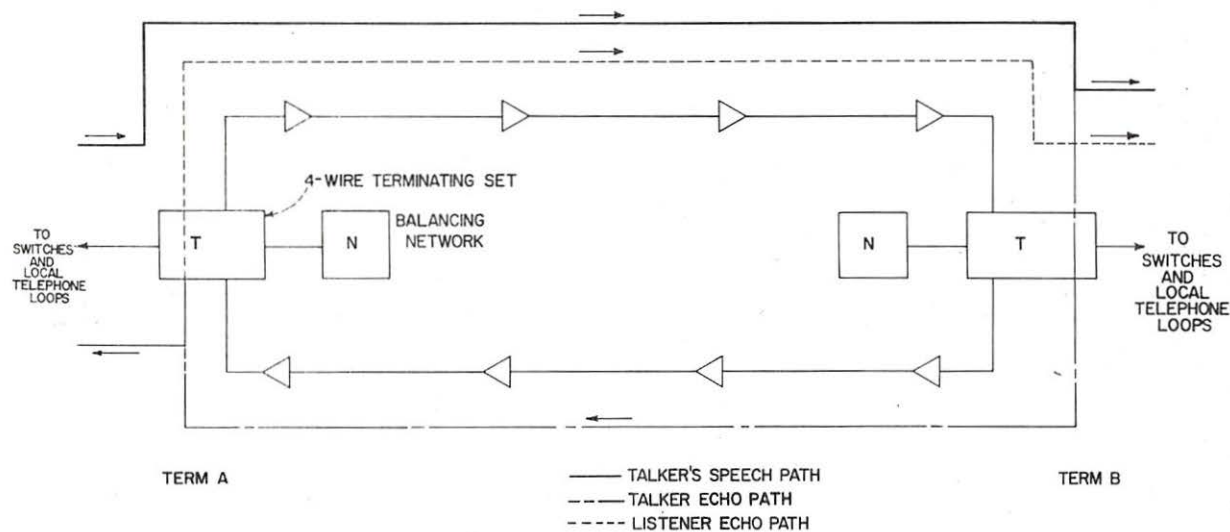
On two-wire circuits, echoes result at impedance mismatches or improper impedance at circuit terminations. A poorly-adjusted balancing network at the hybrid coils associated with two-wire repeaters also permits an echo to return to the talker (under such conditions, however, echoes also return from hybrid coils at the ends of four-wire circuits).

Echo Return Loss.

Figure 3 shows a simple case of a four-wire trunk equipped with four-wire terminating sets at each end, the derived two-wire circuit being extended through two-wire switches to two-wire terminations. The two-wire terminations may be: (1) a loaded or nonloaded trunk circuit to a local exchange; (2) local telephone loops consisting of a wide variety of lengths and gauges of cable pairs, both loaded and nonloaded, with from one to ten telephone sets connected at the remote end; (3) carrier-derived trunks; or (4) carrier-derived subscriber lines. This variety of possible two-wire terminations can be expected to present a rather wide range of impedances; under these circumstances the best balancing network that can be selected for the four-wire terminating set will be compromise for the conditions encountered. Such a network is called a "compromise network," and usually consists of a 600-ohm resistor in series with a 2.0-mf capacitor. Obviously, such a compromise network will be a less than perfect balance for any given connection.

What effect will such a compromise network have on echo? When the telephone user at terminal "A" talks, his speech energy (represented by the heavy black line) travels over the circuit to terminal "B" and beyond to the distant listener. Because of the less-than-perfect impedance match at terminal "B" between the compromise network and the two-wire line facility to the telephone, some of this speech energy (the dash-dot-line) is coupled inductively across the four-wire terminating set and into the sending path and is transmitted back to the talker at terminal "A." Thus he may hear his own voice. If the time involved in the speech traveling from terminal "A" to "B" and back to "A" is long enough, and the returned energy is at a sufficiently high level, the talker at "A" will hear a distinct echo.

Since the same variety of two-wire facilities may exist at terminal "A" as at "B," the same potential for impedance mismatches will also be present. As a result, some of the "talker echo" that



Speech and Echo Paths on a Four-Wire Trunk

Fig. 3

returns to terminal "A" will be coupled across the four-wire terminating set at terminal "A" and returned to terminal "B" (shown by the dashed line) as "listener" echo. Because of the additional loss encountered by the "talker" echo at terminal "A" in being converted to "listener" echo, it will be attenuated to such an extent that it usually is not of great concern although it may make the talker sound slightly distorted or "fuzzy."

The level of the "returned" current at both terminals "A" and "B" will of course depend on the talker's speech level but more importantly it will depend on the degree of impedance mismatch between the compromise balancing network and the two-wire circuits. This mismatch can be described in several different ways but commonly is referred to as "terminal return loss," and expressed as:

$$\text{Return Loss: (db)} = 20 \log \frac{Z_N + Z_L}{Z_N - Z_L}$$

where Z_N is the impedance of the network and Z_L is the impedance of the two-wire facilities. The impedance of the two-wire circuits varies considerably with frequency; therefore, the return loss will also vary with frequency and usually will be poorest in the band of frequencies below 500 Hz or above 2500 Hz. The region between these two frequencies is usually called the "echo band" of frequencies, since the frequencies from 500 to 2500 Hz tend to be least attenuated by the transmission path and are most effectively heard by the average listener.

The echo characteristic of a connection therefore is a function of its length, the velocity of propagation of the transmission path, and the return loss attained in balancing the four-wire terminating sets. To achieve the lowest possible losses in the transmission path, it becomes necessary to achieve the highest possible return loss at the four-wire terminating set. This is the reason it is possible on extremely long circuits to achieve lower attenuation by operating them end-to-end on a four-wire basis; by thus eliminating the four-wire terminating sets, one can achieve substantially infinite return loss.

If any part of an extremely long circuit is operated on a two-wire basis, reasonably satisfactory attenuation can also be achieved by the use of echo suppressors. However, echo suppressors also present some serious problems (especially if more than one or two are involved in a long built-up connection) and they tend to interfere with many types of data transmission.

The Talker's Tolerance to Echo.

Extensive tests have shown that a person's tolerance to echo is a function of the time it is delayed in returning to the talker's ear, and the loudness of the echo. There is a wide difference among individuals as to the relative loudness of the echo and the time delay they will tolerate. The results of extensive tests showing the relationships between these two echo parameters as they affect the average talker are shown in Table 1. There is, however, a considerable variation from person to person; statistically, this variation can be expressed as a standard deviation of 2.5 db.

It should be noted that the loss in the echo path referred to in Table 1 consists of the circuit attenuation from terminal "A" to terminal "B," plus the return loss at the four-wire terminating set at "B," plus the attenuation in the return circuit from "B" to "A." The round-trip delay (which is usually expressed in milliseconds) is the total time it takes for the speaker's voice energy to travel from terminal "A" to "B" and back to "A."

TABLE 1

Round-Trip Delay, Milliseconds	Minimum Loss in Echo Path, Decibels (Satisfactory to Average Observer)
0	1.4
20	11.1
40	17.7
60	22.7
80	27.2
100	30.9

Circuit Stability Against Singing.

Again referring to Table 1, it will be seen that if the "listener" echo current returning to terminal "B" is greater than the original talker current arriving at the same point, then a feedback condition is established which will sustain a circulating or "singing" current around the loop that consists of the circuit from "A" to "B," the four-wire terminating set at "B," the circuit from "B" to "A," and the four-wire terminating set at "A." Such a condition may arise at any frequency within the transmitted band, because of low return losses at terminal "A" or terminal "B," an unfortunate phase relationship between the direct and returned currents, and the relatively high gains used in the channels. Stated in another way,

singing will occur at any one frequency if the sum of the gains exceeds the sum of all losses (including return losses) in the loop path described above, and the two currents are in phase. Singing tends to occur in the frequency ranges of 250 to 500 Hz and 2500 to 3200 Hz, thus lying outside of the echo band of frequencies.

Even though actual singing does not take place, transmission impairment may still occur. This is particularly true if the instability is at the lower frequencies. The result is a "hollow" sound that can be described as the effect produced by shouting into an empty barrel. This effect will be particularly noticeable on long, built-up connections if the individual circuits do not have a minimum margin against singing of at least 6 to 10 db under worst-circuit conditions. Singing margin can be described as the gain, which, when added to a given circuit, will just start the singing condition.

Obviously, if high return losses have been achieved over the entire band of frequencies from 250 to 3200 Hz, singing cannot take place; nor can singing take place on a connection consisting entirely of four-wire facilities, because this condition approximates infinite return loss at both terminals.

It was mentioned earlier that much of the switching of telephone circuits in the world is being accomplished on a two-wire basis. When multiplex-derived trunks became popular, it was natural that these also would be switched on a two-wire basis; this necessitated the use of four-wire terminating sets at the end of each link in the built-up connection. On the surface, this requirement would not appear to be particularly disadvantageous, since four-wire terminating sets would be needed in any event if one of the links were to be used for terminating a call to a local station. Unfortunately, the insertion of four-wire terminating sets in order to achieve two-wire switching at intermediate points in a built-up connection also produces the undesirable by-product of creating an echo path through the four-wire terminating set. The resulting echo will be more or less objectionable, depending upon the length of the circuit, its velocity of propagation, and the degree of balance achieved at the four-wire terminating set (which directly affects the ERL of the circuit).

Mention has been made earlier of the need to attenuate the "return" or "echo" currents by at least 15 to 20 db. The minimum echo return loss actually required in the echo path varies with different talkers. In all cases it would be desirable to achieve an infinite loss in the echo path, but this is generally not economically feasible. The ERL that can be achieved by careful design and

adjustment of the network in a four-wire terminating set depends on a number of factors, chief of which is the degree of similarity that can be achieved between the two-wire facility and the balancing network in the four-wire terminating set. If the derived two-wire line merely extends to another two-wire line derived from a four-wire terminating set in the same switching center, the problem is merely one of suitable control of the total resistance in the switching path, and "building out" of the network and the shorter office paths to a common capacitive value. By this procedure an average ERL of from 22 to 27 db can be achieved for multiplex-derived circuits.

In a practical situation, the same four-wire terminating set and associated balancing network will also have to be switched to many different two-wire lines extending outside of the switching center. Since it is not feasible in a two-wire switching center to also switch the network to match the two-wire lines, a "compromise" network must be used which will be common to all of the connections established. This implies that the two-wire trunk lines and local loops must have their impedances modified to approach the impedance of the compromise network. This involves (1) careful design of the switching equipment configuration, (2) control of the minimum attenuation between the four-wire terminating set and the subscriber's loop by insertion of pads, (3) loading of long subscriber's loops, (4) use of loading on substantially all two-wire cable trunks, (5) installation of impedance compensators on the switching-center end of all loaded trunks, (6) use of optimum ratio repeating coils and (7) d-c blocking capacitors of the proper value. Even with all of these steps carried out, it will be possible to achieve an ERL between the four-wire terminating set and the two-wire trunks of only about 18 db, while the ERL of the local loops, even though isolated from the four-wire terminating sets by 2-db pads, will be in the order of 15 db.

Four-Wire Terminating Sets.

It is clear from the above that a network that consists entirely of four-wire facilities and four-wire switches will provide the finest of transmission. But when, as in the commercial DDD network, we must go from two-wire to four-wire facilities and back again to two-wire switches, the decision is not so clear cut. For at each of these transition points we must introduce a four-wire terminating set, and this creates some problems.

As indicated earlier, the telephone subscriber's loops are two-wire, as are most trunks from the local (Class 5) office to the first switching office (the Class 4 office). Two-wire circuits in the local

office cannot very well be switched to two-wire trunk circuits on any other than a two-wire basis, so that takes care of the local end of our trunk circuit.

The problem in the Class 4 office can be somewhat different, for there the two-wire trunks meet the four-wire trunks and a four-wire terminating set must be used. The question to be resolved is one of determining whether the four-wire terminating set shall be permanently connected to the intertoll circuits or to the toll terminating circuits; the problem of obtaining an adequate balance will be substantially the same in either case. Purely on the basis of the quantity of circuits of the two types that will be involved, it usually will be economically attractive to install the four-wire terminating sets on the four-wire intertoll trunks, leaving the two-wire side to be switched. This implies using compromise networks in the four-wire terminating sets and will require terminal balancing of the switching center.

In many situations, more than one local (Class 5) office will home on the same Class 4 switching center. In such situations, calls between the several local offices can be established by switching together two-wire trunks at the Class 4 switching center.

Such an arrangement usually presents no transmission difficulties, nor will supplementary gain be needed on these calls. If, however, the Class 4 switching center is arranged for four-wire switching and, as usual, is arranged to transfer from the four-wire intertoll to the two-wire toll terminal circuits by the pad-switching technique, then on switching together two such terminal trunks, additional gain may be needed. This is required not because of the four-wire terminating sets on the two-wire circuits but to make up for the gain that is not being provided by transferring gain from the intertoll circuits. Obviously, arrangements requiring gain are likely to be more costly even after making allowance for the elimination of terminal balancing, which will not be required with a four-wire switching center.

As of the present moment, there are relatively few primary switching centers (Class 3 offices) in Independent territory; therefore, the decision as between two-wire and four-wire switching will usually, for the time being at least, be left up to others. But what factors are different in a Class 3 switching center which might affect a choice between two-wire and four-wire switching? The major difference will involve through connections between Class 2 and Class 4 offices. These connections can gain technical advantages from being switched on a four-wire basis. If many circuits are to be switched in a Class 3 office, it may be economical to use

four-wire switching equipment and thereby avoid an extensive terminal-balancing job. If four-wire through-switching is provided, then four-wire switching will also apply for the terminating calls.

Conclusions.

From the foregoing discussion it will be evident that there are transmission factors in favor of four-wire switching, especially on through connections at Class 3 offices. It may not be so evident, but nevertheless there usually are substantial economic factors in favor of two-wire switching, especially at Class 4 offices. Two-wire switching appears to be the only feasible method at a local (Class 5) office.

It is believed that these conclusions are valid and can be substantiated for almost any situation and this would indicate that four-wire switching has only a very limited application in Independent Telephone operations at this time. It must be added, however, that Independent companies may well find themselves being called on to supply four-wire facilities and four-wire switching equipment for any number of private-line switched networks. These networks are hardly to be compared with that portion of the commercial networks to which most Independent companies are exposed. The private-line networks frequently consist of facilities and switching centers that constitute a full-fledged switching hierarchy in their own right and accordingly will need to be designed to meet the same stringent requirements as are imposed on the commercial DDD network. In these situations, four-wire switching may very well be indicated for a number of reasons, including the fact that a new installation may be involved and modification of an existing installation is not required.

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Exhibit 9-C

SPEECH-PLUS-DUPLEX OPERATIONS OVER
TELEPHONE TRUNK CIRCUITS

General Description.

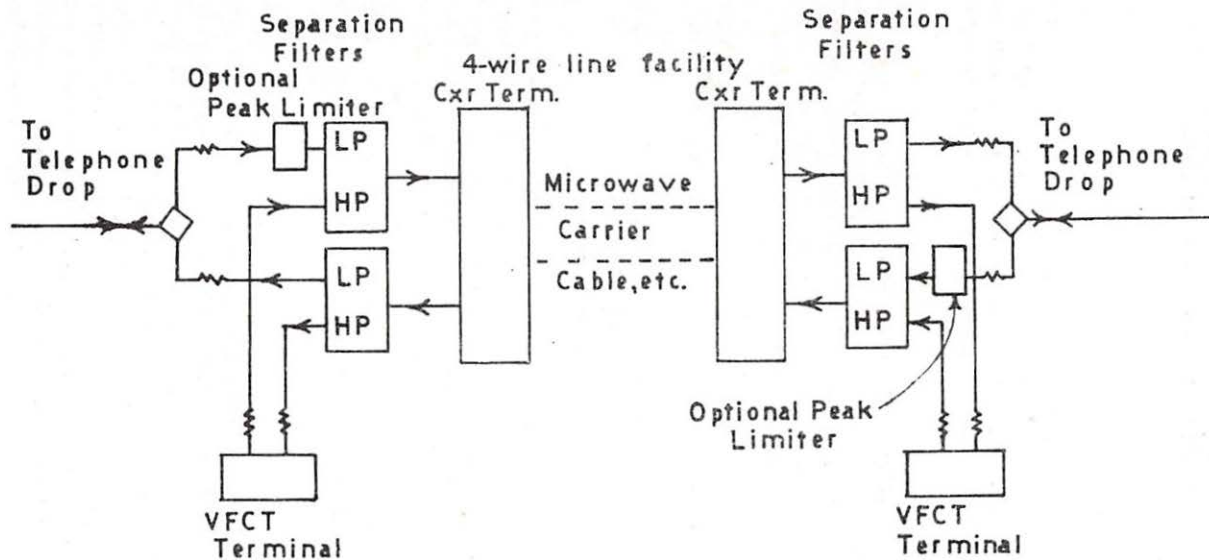
Frequently, the economics of developing communications facilities into remote areas where traffic requirements are relatively light force consideration of methods of deriving circuitry which would not normally be used. Speech-Plus-Duplex is one such arrangement.

Speech-Plus-Duplex is the term applied to the technique of using one voice channel to derive simultaneously one telephone circuit and one or more telegraph circuits. Usually, telegraph, teleprinter, telemetry and control circuits are derived by applying voice frequency carrier telegraph equipment in groups of channels from one up to eighteen to a four-wire carrier-derived voice channel, while at the same time telephone circuits are not required to share their voice channels with any other service. As with many expedients, the economies are not achieved without some sacrifice. In the case of Speech-Plus-Duplex, this sacrifice is in the quality of the telephone circuit since its frequency bandwidth must be reduced to accommodate the telegraph channels.

The frequency band assigned to telegraph is separated from that assigned to the telephone circuit by means of filters. Most often the band for telegraph is located at the top end of the voice channel. For instance, 2200 Hz to 3000 Hz, but it is also possible to use a band in the middle of the voice channel, in effect splitting the telephone signals into two bands. Figure 1 shows the application of filters to a four-wire voice circuit to derive Speech-Plus-Duplex telephone and telegraph circuits. Figure 2 shows the alternative.

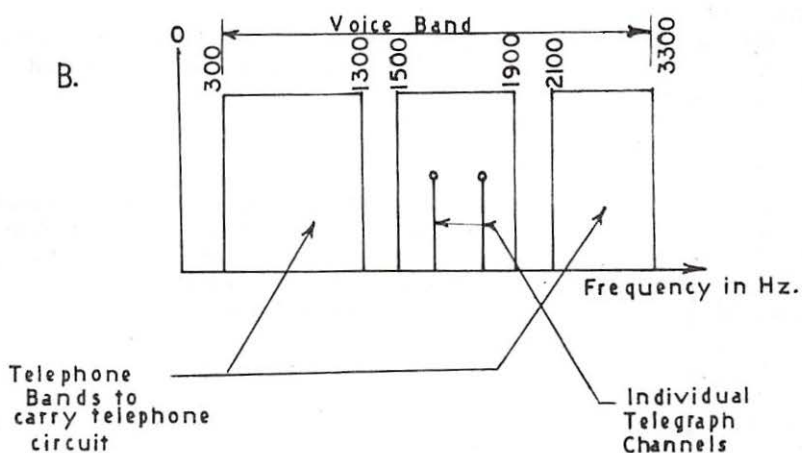
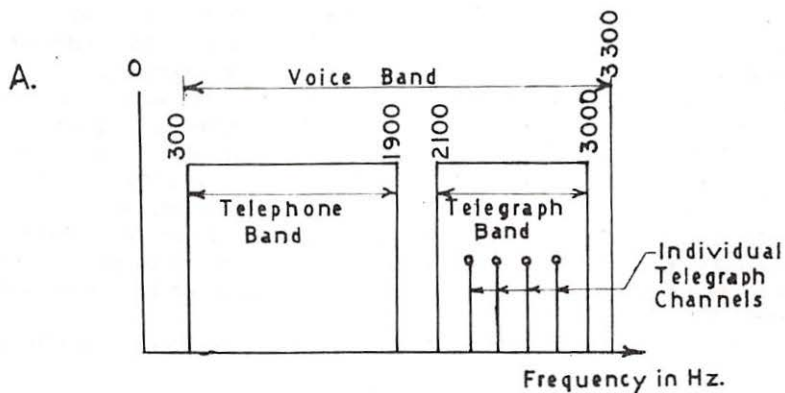
Filters.

The characteristics of the filters should be such that the telephone circuit and the telegraph circuits will be prevented from mutually interfering, at the same time introducing the minimum amount of distortion. Across the passbands the filters attenuation-frequency response should be flat within ± 1 db and the cutoff should take place as rapidly as possible. With the telegraph signal levels which are recommended in the paragraph on telegraph circuits below, an attenuation of at least 45 db should be achieved across the stop bands of the filters in order to reduce the levels of the telegraph tones below the noise level to be expected in the telephone



General Arrangement of Components in Speech-Plus-Duplex

Fig. 1



Alternative Frequency Arrangements for Speech-Plus-Duplex

Fig. 2

circuit which will be in the order of -25 dba0. Likewise a minimum of 45 db attenuation will be required to protect the telegraph channels from interference caused by momentary peaks in the telephone circuit.

Telephone Circuit.

Normal design practices may be applied to the layout of the telephone circuit once allowance has been made for the reduced frequency bandwidth. As shown in Fig. 1, the telephone circuit may be extended on either four-wire or two-wire basis to the exchange equipment or drops. Because the maximum frequency which will be passed over the telephone circuit will, in all probability, be below 2500 Hz in-band SF signaling at 2600 Hz will not be suitable and so a substitute will have to be found. If the voice channel is equipped with standard out-of-band E and M signaling, usually operating at 3825 Hz, this may be used. Failing this, the dial signaling channel must be derived in-band, using one of two possibilities:

1. Assigned to one of the telegraph channels of the Speech-Plus-Duplex.
2. In-band on the telephone circuit using 1 VF or 2 VF equipment operating below 2000 Hz.

Since the bandwidth of the telephone channel has been restricted, the apparent loudness and intelligibility of the voice signal will be reduced, depending on what particular upper limit is selected for the telephone circuit.

Telegraph Circuits.

The number and speed of transmission of the telegraph channels to be derived by Speech-Plus-Duplex will determine the cutoff frequency for the separation filters. For 80 baud transmission speed, the standard 170 Hz frequency spacing between nominal carrier frequencies for FM voice frequency telegraph may be used:

2295 Hz; 2465 Hz; 2635 Hz; 2805 Hz; 2975 Hz and 3145 Hz

The ability to use the three highest assignments will depend upon the cutoff frequency of the voice channel, which with modern types of carrier systems may usually be taken as 3300 Hz. With Type C carriers and single-channel stackable carriers the three highest channels cannot be used. Higher-speed channels, such as those operating up to 200 baud, use 340 Hz channel separation and hence

it may be expected that only two or, at the most, three channels of this type could be assigned.

The cutoff frequency for the separation filters is determined by the lowest telegraph channel. At least 300 Hz should be allowed between the cutoff of the separation filters and nominal center frequency of the lowest telegraph channel.

Care must be used in selecting the operating levels for the telegraph channels in order to have adequate margin against errors caused by noise and yet not overload the transmission system. Most multichannel facilities, such as microwave systems, multiplex, cable carriers and wire line carriers, are designed on the assumption that the average power in a voice channel will be -15 dbm0. The integrated level shall not exceed 16 db below test tone at the input to the modulator.

Applications.

In modern, high-quality, switched telephone networks, the use of Speech-Plus-Duplex should be avoided as transmission performance is significantly degraded. There is also the possibility that momentary and spurious peaks of signal on the telephone circuit may break through the filters and cause errors on the telegraph circuits, making consideration of peak limiters on the telephone circuit desirable. As a general rule, Speech-Plus-Duplex should be limited to those cases where it is the only economical solution for providing limited telephone and telegraph requirements.

Exhibit 9-D

CONVERTER CIRCUITS TO PERMIT DIFFERENT
TYPES OF SIGNAL SYSTEMS TO BE INTER-
CONNECTED ON A D-C BASIS

When it is necessary to connect end-to-end voice carrier channels equipped with different types of signaling, first consideration should be given to single-frequency in-band signaling over the entire length of the combined circuit. If this type of signaling is not feasible in the given situation, the signaling systems may be connected on a d-c basis, with possible degradation of the signaling performance.

Most modern carrier equipment is arranged for E and M signaling. If ringdown operation is desired, an applique is added between the drop and the carrier terminal to provide conversion between the 20-cycle and the E and M signaling.

Figure 1 shows a typical connection of a carrier channel E and M signaling equipment to a PBX dial trunk. Note that the voltages for operating the signaling equipment are provided by the PBX. Most carrier equipment is provided with strapping for operation with either 22-volt or 48-volt PBX equipment. When carrier channels equipped for E and M signaling are connected end to end, an external power source is required.

Figure 2 shows alternate schemes for interconnecting two carrier terminals equipped for E and M signaling, where the signaling relay controls and contacts are available for reconnection as shown.

Where the signaling relay controls and contacts are not available for reconnection, a signaling converter is required. Figure 3 shows a typical arrangement of this type.

Figure 4 shows the interconnection of an "H" carrier with a channel equipped for E and M signaling. With ringdown operating it is assumed that the signaling receive relay of the E and M equipped carrier is normally de-energized. If no normally-open contact is available, a signaling converter similar to that shown in Fig. 3 will be required.

Figure 5 shows the connection of a carrier channel equipped with a 1000-cycle ringer oscillator to a channel equipped for E and M signaling. A normally open contact is required on the signaling

receive relay of the E and M equipped channel. If this contact is not provided, a signaling converter similar to that shown in Fig. 3 will be required.

Carrier systems having solid state signaling transmitters in lieu of signal send relays may be connected with other systems in the same manner as those shown. The keying terminals of the solid state signal transmitter should be connected in place of the control winding of the signal send relay shown in the figures. Care must be taken that the keying (dry contact, ground or voltage) of the transmitter is of the correct type. If the type required cannot be derived from the signal receiver of the connecting channel, a signaling converter is required.

The foregoing discussion and figures are given typical examples. The type of carrier involved in specific cases will have to be studied to determine a suitable arrangement.

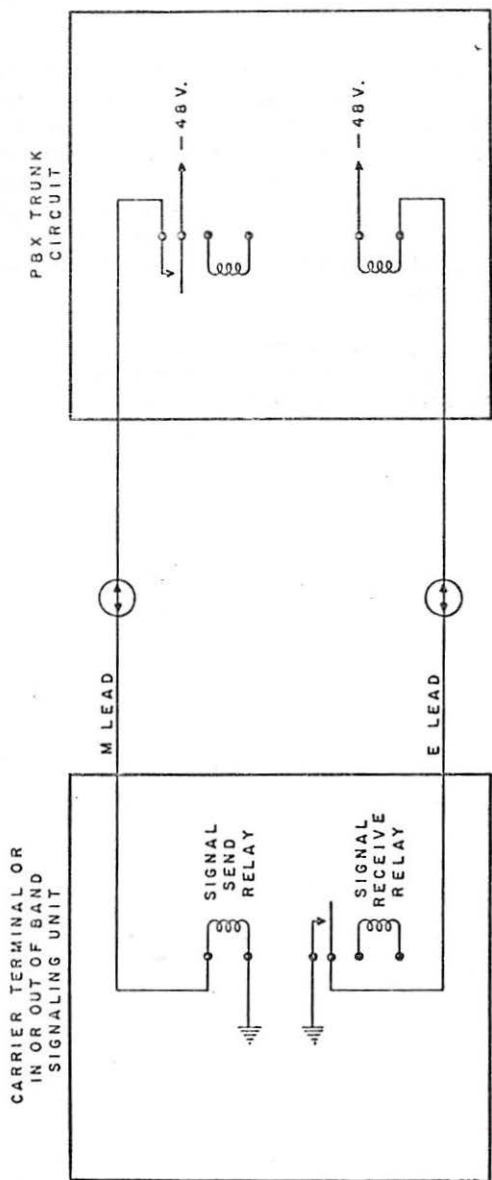
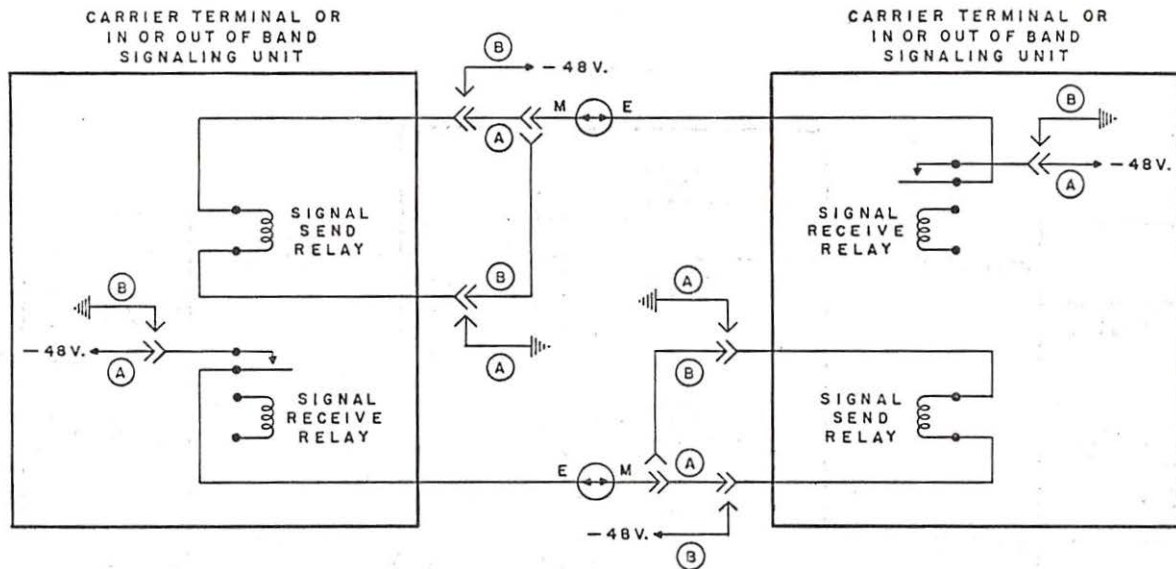


Fig. 1



NOTE: E lead wiring on one terminal must correspond to M lead wiring of opposite terminal (A or B wiring).

Fig. 2

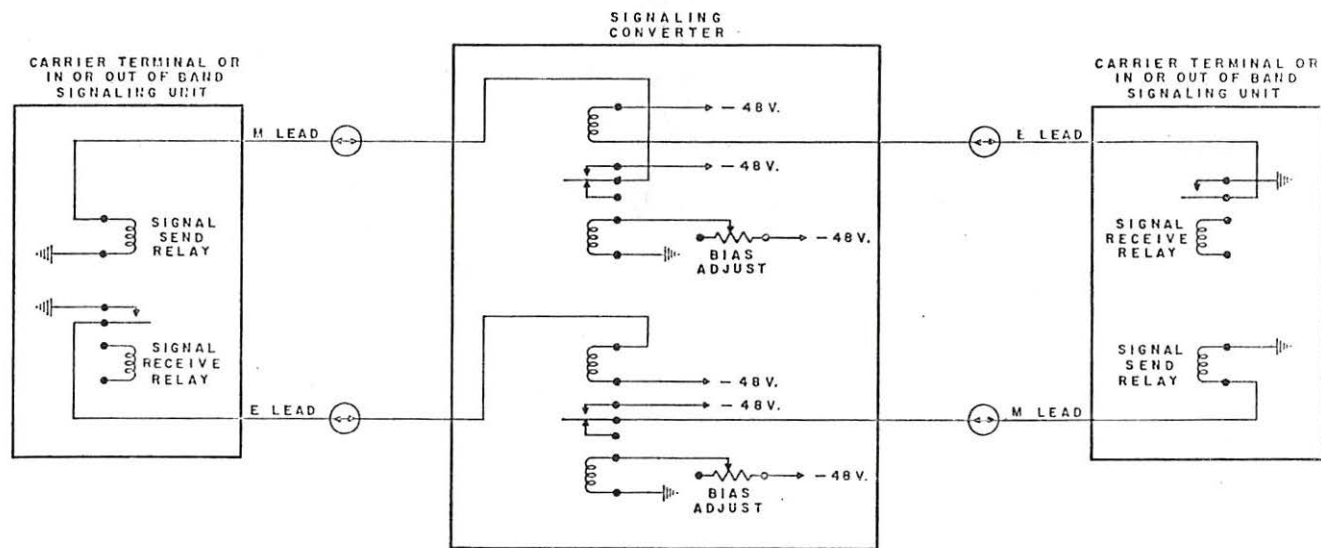
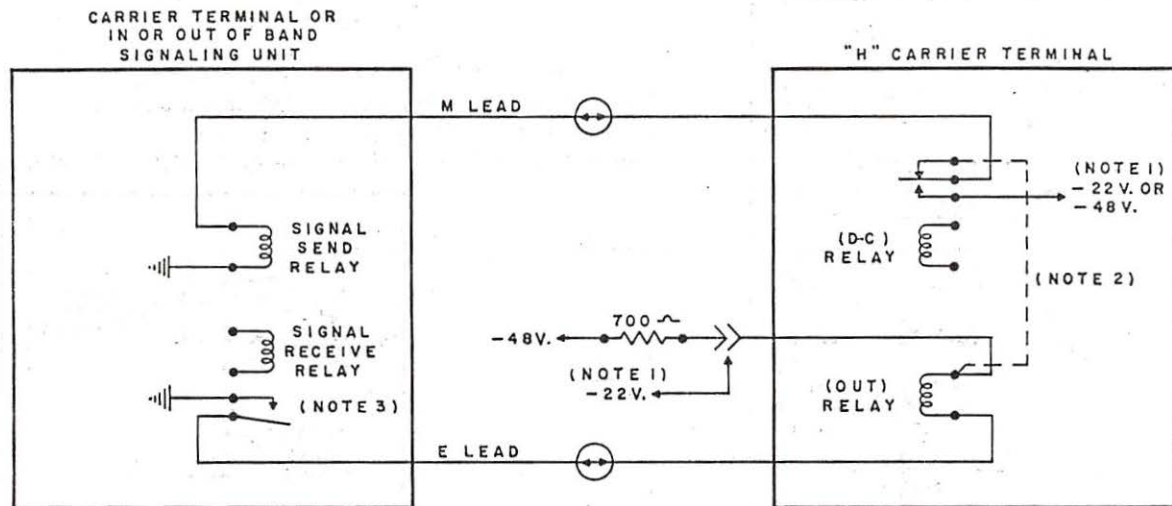


Fig. 3



- NOTES: 1. H carrier relay circuit power supply may be used to supply -22 volts.
2. Remove dashed wiring.
3. If contact on receive relay is not available, one half of signaling converter shown in Fig. 3 required.

Fig. 4

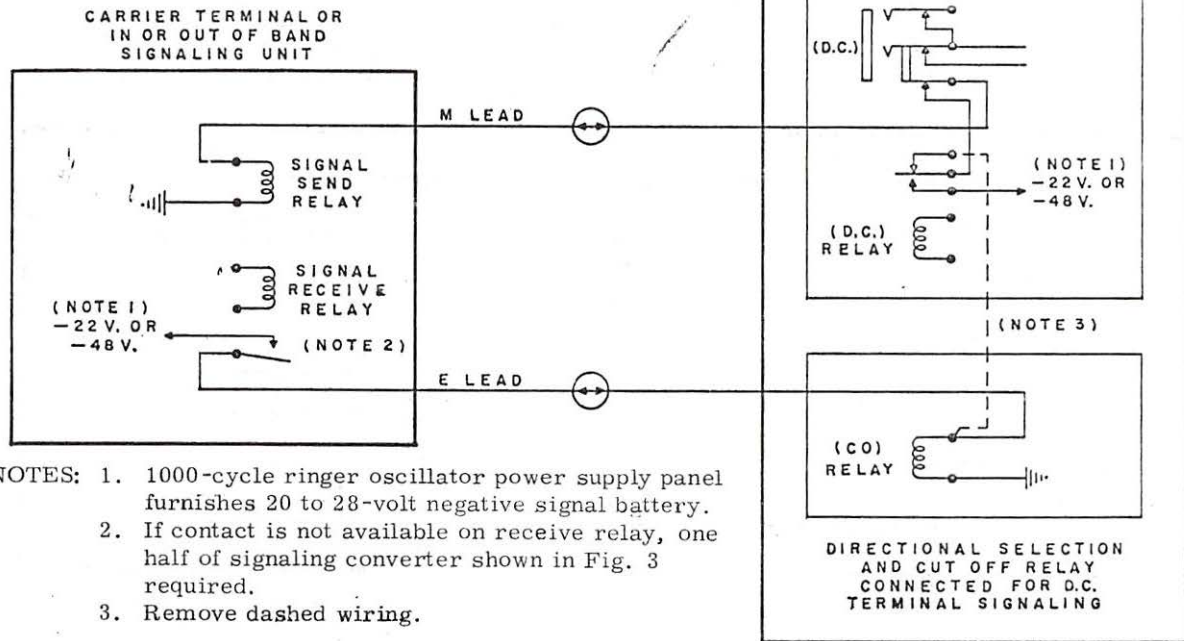
WESTERN ELECTRIC
1000 CYCLE RINGER
OSCILLATOR

Fig. 5

Exhibit 9-E

CHARACTERISTICS OF COMPUTERIZED MESSAGE
SWITCHING CENTERS PLACED IN SERVICE ON
RAILROADS SINCE JANUARY 1, 1966

	C&O	DRGW
GENERAL		
Date in service.....	Dec. 1966	Feb. 1967
Location.....	Huntington, W. Va.	Denver, Colo.
Manufacturer	RCA	GE
Original program by	RCA	DRGW
Program maintenance by	C&O	DRGW
Hardware maintenance by	RCA	GE
Hours and days operated	24, 7	24, 7
Messages in per day	3825	2500 (est.)
Messages out per day	5005	---
Average char. per message.....	2700	800 (est.)
Total char. in and out per day	23, 841, 000	---
Types of messages	Car Rptg., Adm., Inquiries	Car Rptg., Inquiries, Adm., Svc.
COMPUTER		
Fallback provided	yes	yes
Core size	80, 000 char.	16, 484 words
Bits per word	42 (7 per char.)	18
MASS STORAGE		
Type	Drum	Disc
Capacity Characters	1, 310, 720	22, 000, 000
Fallback provided	yes	yes
Tape stands	4	4
OPERATING FEATURES		
Speed conversion.....	yes	no
Code conversion	yes	no
Format conversion	yes	---
Message headings edited	yes	yes
Retrievals made	yes	yes
Incoming message nos. checked	yes	yes
Outgoing message nos. assigned.....	yes	yes

CHARACTERISTICS OF COMPUTERIZED MESSAGE
SWITCHING CENTERS PLACED IN SERVICE ON
RAILROADS SINCE JANUARY 1, 1966

(Continued)

	C&O	DRGW
OPERATING FEATURES--Cont'd.		
Date time assigned	yes	yes
Controls available.....	Redirect, hold, skip	yes
Computer switchover	Manual	Manual
Can fallback computer be used for data processing?.....	no	yes
History tape	yes	no
Logs kept	yes	yes
High speed readout	Magnetic tape	no
LINES		
Speeds	100 wpm and 2400 wpm	110 baud
No. of: FDX non-controlled..	---	3
FDX controlled.....	---	19
HDX non-controlled..	---	---
HDX controlled.....	58 (includes 2-2 400 wpm)	---
SX non-controlled ...	---	---
SX controlled	---	---
Total.....	58	22
OUTSTATIONS		
Number	132	38
Terminal equipment type.....	28TT machines	33TT, 35TT machines

Exhibit 9-F

HIGH VOLTAGE DIRECT CURRENT TRANSMISSION

High voltage direct current (HVDC) transmission is an enigma to today's railroad communication and signal engineers and to the corrosion engineers in the pipeline and allied industries.

It was Thomas Edison's direct current techniques that were utilized in the early days of power generation and transmission. This interest in transmitting blocks of electric power lead to the development of early experimental direct current systems in the late 19th Century by engineers such as Charles Francis Brush in the United States, Marcel Duprez and his protege Rene Thury in France. Thury, in 1889-90, made a major breakthrough in d-c transmission, increasing voltage and power by connecting 18 generators in series to develop 14,000 volts delivering 630 kw over a line length of 35 miles. Thury's greatest achievement was a system he developed in 1906 and later expanded to transmit 1800 kw at 125 kv for a distance of 112 miles. This was the Moutiers-Lyons D-C system which remained in service for 31 years. With the development of alternating current theories and techniques by Steinmetz and other researchers, which permitted transforming low-voltage alternating current to higher voltages, and vice versa, thus simplifying transmission of electric energy, the interest in the transmission of electric power using direct current diminished because of the many problems involved.

During the early 1900's, research began on mercury arc rectifiers. By 1928, these rectifiers had ratings of 16,000 volts at 150 amps. As a result of the success in developing these high performance rectifiers, interest was renewed in d-c transmission. Most d-c transmission lines developed during this period were essentially short experimental lines associated with industrial plants and demonstrated frequency conversion advantages.

European and United States research in the development of d-c rectifiers took two distinct paths. The United States research centered on the heated cathode or thyatron types. The European, typified by Swedish researchers, concentrated on the development of mercury pool rectifiers, and with these rectifiers they were able to develop high performance and make great progress in d-c transmission. It should be noted that d-c transmission of large blocks of electric energy has now become feasible with the development of the high performance mercury pool rectifier (commonly called a "valve").

As a result of its leadership in rectifier design, a Swedish company has been instrumental in the construction of all d-c transmission systems constructed in the Free World. Incidentally, one system of Russian design is being planned to operate between Volgograd and Donbass, at a voltage of 800 kv for a distance of 300 miles to carry 750 mw.

The present operative Free World systems are:

<u>Location</u>	<u>Voltage, Current Cap.,</u>		<u>Length</u>	<u>Type</u>	<u>Installed</u>
	<u>kv</u>	<u>amps</u>			
Sweden	100	200	60 mi.	Monopolar cable-sea return	1954
English Channel	± 100	800	40 mi.	Bipolar Cable	1961
New Zealand	± 250	1200	25 mi. cable 355 mi. over- head	Bipolar with Mono- polar capa- bility (most operation monopolar with sea re- turn	1965
Italy	250	1000	61 mi. -cable 217 mi. over- head	Monopolar with sea re- turn	1965
Canada	260	1200	43 mi.	Monopolar cable-sea return	1967

One element that is common to all of the above operative systems, is that all or part of the HVDC transmission line is made up of submarine cable. Due to shunt capacitance in cables, a-c charging currents soon approach the thermal limit of the cable insulation; while in d-c transmission systems this charging current does not exist. As a result, much higher loads are feasible. Also of note is the practice of using sea electrodes in monopolar (one rectifier pole to the transmission conductor and the other pole to the ground electrode) operation.

The Pacific Northwest-Pacific Southwest Intertie HVDC transmission lines, shown in Fig. 1, are the highest capacity and

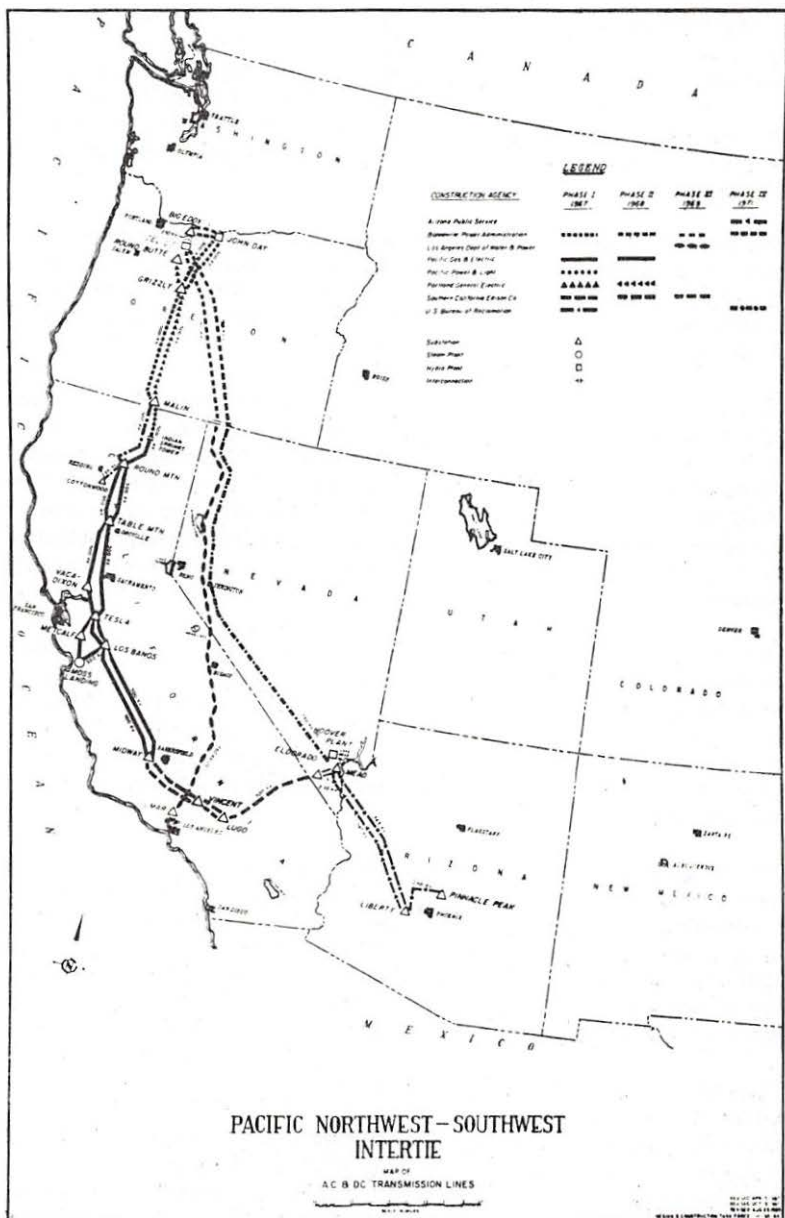


Fig. 1

longest lines of this type contemplated to date, and are now under construction. These HVDC Interties consist of two separate + 400-kv, 1800-amp transmission lines - the Celilo-Sylmar line 851 miles long and the Celilo-Mead line 815 miles long. Each of these lines consist of two conductors on one supporting tower and information disseminated to date by the sponsors¹ of these HVDC transmission lines indicates that they are to be operated bipolar (one rectifier pole to one line conductor and the other rectifier pole to the other line conductor).

To permit maintaining the insulation of the converters (rectifiers) and inverters at a lower level, each terminal consists of two units (converters or inverters) of 400 kv each connected in series with the midpoint connected to the ground electrodes at Celilo and Mead, and a sea electrode at Sylmar.

Projects of this magnitude venture into many unexplored realms where previous knowledge and experience is limited. Because of this lack of knowledge, the Bonneville Power Administration has sponsored research to develop the designs for these systems. This research, most of which is under carefully controlled laboratory conditions, together with computer-derived conclusions, certainly does not anticipate all of the problems that can arise during actual operation.

Construction of these two systems is proceeding with a completion date for the Celilo-Sylmar of mid-1968 and the Celilo-Mead line for completion in 1969, and yet not all of the terminal design is completed. It is in this area that the greatest number of unanswered questions exist. It is also this area that is of the greatest interest to the railroad communication engineers and communication companies.

In the operation of converters and inverters, many harmonics of the fundamental 60-cycle supply or output are generated due to the conversion or inversion processes. These harmonics are noise voltages which can be inductively coupled from a-c and d-c line facilities to nearby communications circuits. Industrial plants using large blocks of d-c energy produced by converters have frequently been a source of interference to adjacent communications circuits.

Dependent upon converter and inverter design interference can be expected at the 5th, 7th, 11th and 13th and even at higher harmonics by radiation from the a-c transmission lines connecting with the converter and inverter terminals (Celilo-Sylmar and Mead). These harmonics are the idealized theoretical harmonics, and in no way include all harmonic voltages which may be present.

Similarly theoretical harmonics present on the d-c line are the 6th (occasionally) and the 12th harmonic. Here again the actual harmonics are relatively unknown. No estimate of TIF (telephone influence factor) is available at this time because no decision by the sponsors has been made on the amount of filtering to be furnished ².

Proper filtering of the a-c and d-c lines serving the converter and inverter is the only practical method to eliminate harmonic interference. It must be eliminated at the source. Once the interference appears on the railroad communications or signal facility, it can only be removed at the expense of removing intelligence from the facility along with the interference. This is impractical and not desirable.

Adequate filtering is the only practical way to eliminate the noise as in most locations the a-c transmission lines which will radiate the harmonic components are already in service. Only a few new a-c feeder lines are to be constructed to interconnect the converter and inverter terminals with existent transmission lines. Little flexibility remains in furnishing adequate separation unless the power industry will relocate many existing lines. Certainly the least costly approach is to filter at the source of interference.

Railroad interest in HVDC is reflected by their concern for interference with signal as well as communications facilities. Harmonic interference to dispatcher telephone circuits, message telephone and other local physical circuits, as well as voice frequency carrier circuits (CTC-TCC-hot box indicators and similar uses) has always been a problem which communications departments have faced. Harmonic interference with the relatively new audio frequency devices now being used in track circuits is a problem not previously experienced. Until additional information or experience is developed to indicate otherwise, caution in choice of AFO channels should be exercised where harmonic interference is possible.

Closely related to terminal design is the fundamental question raised by the presence of ground electrodes and/or sea electrodes. Since the HVDC Intertie is designed for monopolar operation under emergency conditions (sponsors say not over 8 hrs. per year), the question of the effect ground currents will have on rails and other grounded or buried structures arises.

When a direct current enters the ground, a voltage is developed across the many parallel resistance paths formed by the earth adjacent to the ground electrode. The voltages seen along the surface of the earth form a voltage gradient. Electric current takes all available paths inversely proportional to the resistance of the path.

Where the path of the current includes a track structure, a voltage will be developed between the rails should the resistance to ground be unbalanced. This voltage, under proper conditions, can cause rail current to flow, resulting in an unsafe condition particularly where broken rail protection is expected³⁻⁴.

The monopole operation of HVDC will also cause current to flow in metallic structures located in the vicinity of the ground electrode, such as pipelines, causing electrolysis to these structures. As cathodic protection is added by the pipeline industry to protect their pipelines from electrolysis, other earth currents will be developed which are not as well isolated from the railroads as the power groups planned ground electrodes. It is conceivable that a far greater problem will be created for the railroad industry as the pipeline industry applies cathodic protection to their facilities, than the primary cause, the ground currents due to the monopole (ground return) operation of the HVDC transmission line.

The telephone industry appears at this time little interested in the effects of ground current, since their spokesmen advise that a large part of their underground cable system is now plastic jacketed and the older lead sheath cables are very rapidly being replaced.

Investigations of radio interference (RI) emanating from HVDC transmission lines indicates no interference will result to railroad radio systems. Measurements made by television (TV) interference meters could only detect interference directly under the conductors at voltages above 500 kv. Few differences in RI can be expected between d-c and a-c lines during dry weather. However, where a-c lines emanate higher RI during precipitation, d-c RI decreased below fair weather levels. Broadcast receivers operated in the presence of RI from d-c transmission lines can tolerate a much higher RI level than from an a-c transmission line. Measurements made by TV interference meters could only detect interference under the conductors at voltages above 500 kv.

Other effects may be caused by the presence of HVDC, such as that caused by the flow of current through an overhead conductor with earth return. With a 2000-amp current flowing, the magnetic field density would equal the earth's magnetic field at a distance of about 70 ft. Generally, it is not likely that this magnetic field will affect anything of interest to the railroad industry. It should be noted that the English Channel HVDC was operated bipolar to avoid interference with ship's magnetic compasses.

Electrostatic coupling under monopolar operation may establish a capacity voltage divider network to communication and signal line conductors of such magnitude as to cause operation of low-voltage

lightning protectors. Once again interference to railroad communications and signal facilities will be caused by monopolar operation.

That there is a great deal of interest in HVDC by the railroad industry is to be expected. HVDC transmission as pointed out above is a new medium for electric energy transmission and there are many problems that are still under study to find acceptable solutions to all industries involved.

HVDC has definite advantages, since it permits the transmission of large blocks of electric energy for infinite distances at the lowest possible cost, both as to investment and operation, especially when monopolar (ground return) operation is utilized. This system is fully reversible and avoids the large investment in oil circuit breakers for protection and switching. Further, it minimizes voltage transients and all the many problems entailed with the transmission of high voltage and large quantities of power by a-c. When HVDC transmission lines are used for interties between large power grids, there is one special benefit in that the generators in the two power grids do not have to be operating synchronously either to phase or frequency. The economies of HVDC transmission are such that the electrical power industry can afford to take all necessary measures to protect communication facilities, regardless of the type, from interference by harmonics generated anywhere in the electric transmission system or power grid.

Railroads, pipelines, the communications industry, and similar organizations cannot stand in the way of development of HVDC techniques and utilization, but must work closely with their proponents to obtain maximum protection to their operations. It is very possible that Congressional enactment whereby many electric power utilities, privately owned or Federal Agency, must adopt and comply with the National Electrical Safety Code⁵. Further, to prevent inductive interference, the requirements set forth in the Joint Study of the Bell System-Edison Electrical Institute⁶ should be strictly adhered to.

HVDC presently is of much concern to the Western Railroads because of their proximity to these transmission lines now under construction. But future cost reductions in converter and inverter terminals will make HVDC transmission economical for shorter distances. As economy in design dictates, newer systems will be developed throughout the United States. Other reasons may force early introduction of HVDC elsewhere. In Japan, one system is used because of the need for frequency conversion. HVDC may find early use in interconnecting major power pools with minimum chance for an enlarged Northeast Power Blackout.

What are the essentials of HVDC transmission design which protect the railroad interest? They are simply:

1. Bipolar operation.
2. Adequate filtering of a-c and d-c lines.

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REPORT OF

COMMITTEE 10--INTERLOCKING, TRAFFIC CONTROL
AND BLOCK SIGNALING

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Consulting Members

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July 1, 1967

TO THE COMMUNICATION AND SIGNAL SECTION:

The following subjects have been assigned to this committee:

1. General review of Manual.
2. Report to the Special Committee on Research Assignments any projects considered proper for submission to AAR Research Center.
3. Preparation of economic statements, as deemed desirable, on items coming within the scope of the committee's activities.

4. Specification for yard switching system.
5. Investigate and report on methods of improving shunting of track circuits.
6. Collaborate with AAR Joint Committee on Relation Between Track and Equipment in the study respecting the rollability of cars.
9. Collaborate with Mechanical Division Committee on Car Construction, on the subject of Car Designs-Dimensions and Clearances.
11. Investigate and report on the effects of continuous rail on insulated joints.
13. Investigate and report on various types of detectors used in connection with signal systems for protection of trains and equipment.
14. Investigate and report on methods of installation of track circuit connections to facilitate the use of mechanized track maintenance equipment.
15. Investigate and report on all phases of retardation and automatic route selection in classification yards equipped with car retarder systems.
21. Investigate and report on the effect of concrete ties on signal circuits, collaborating with AREA Committee 3--Ties and Wood Preservation.
22. Investigate and report on methods for eliminating insulated joints in railroad track in connection with signal facilities.
23. Prepare requisites for surge protectors.
25. Investigate and report on performance of insulated joints.
 - (a) Insulation.
 - (b) Joint bars.

The committee submits for consideration, reports on the following subjects:

1. Signal Manual Part 27--Specification 147-59--Car Retarder System, revised as shown in Exhibit 10-A, page 260.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 59--Requisites for Track Circuits, revised as shown in Exhibit 10-B, page 284.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 64--Requisites for Movable Bridge Interlocking, revised as shown in Exhibit 10-C, page 286.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 205--Requisites for Protection of Traffic Against Slides and Rock Falls, revised as shown in Exhibit 10-D, page 287.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

1. Signal Manual Part 217--Requisites for Dragging Equipment Detection, revised as shown in Exhibit 10-E, page 288.

Action Recommended

Approval to supersede subject matter in the Signal Manual.

3. Controlled Yard Switching System, as Exhibit 10-F, page 289.

Action Recommended

Acceptance as information.

11. An excellent paper on this assignment entitled "Santa Fe Tests Insulated Joints," by Mr. F. H. Smith, Assistant Engineer, Santa Fe Railway System, was given at the Western Sectional Meeting held in St. Louis, Mo. on April 6, 1966. The paper was published in the July 1966 issue of Railway Signaling and Communications magazine. Copies of this article are available from the Secretary's office upon request.

Action Recommended

Acceptance as information.

Respectfully submitted,

COMMITTEE 10--INTERLOCKING,
TRAFFIC CONTROL AND BLOCK
SIGNALING

Exhibit 10-A

(Revised Signal Manual Part 27)

SPECIFICATION FOR CLASSIFICATION
YARD SYSTEMS

1967

General Provisions

1. Purpose.

(a) This specification is for the purpose of providing for the installation of a car retarder system. It sets forth specific detail requirements representing modern signal practice recommended for new installations and for the replacement of existing installations when general renewal or replacement is to be made.

2. Details of work.

(a) Details of work include the following:

1. Car retarder and fittings.
2. Switch operating mechanism and fittings.
 - (a) Classification tracks.
 - (b) Other tracks.
3. Retarder controls.
4. Switch controls.
5. Control machines.
6. Automatic Car Identification (ACI) systems.
7. Signal and indicator systems:
 - (a) Hump signals.
 - (b) Repeater signals.
 - (c) Trimmer signals.
 - (d) Switch signals.
 - (e) Cab signals.
 - (f) Audible signals.
 - (g) Yard track indicators.
 - (h) Shove indicators.
 - (i) Dragging equipment indicators.
 - (j) Broken flange indicators.
 - (k) Loose wheel indicators.
 - (l) Hot bearing indicators.

Note. --The recommended forms of construction contracts and bond will be found in the Manual of the American Railway Engineering Assn., Chapter 20--Contract Forms, Part 1.

2. Details of work.--Continued.

8. Communication systems:

- (a) Telephones.
- (b) Loudspeakers.
- (c) Radio.
- (d) Teleprinters.
- (e) Pneumatic tubes.
- (f) Television.
- (g) Facsimile.
- (h) Recorders.

9. Buildings.

10. Power supply.

11. Power distribution system:

- (a) Aerial.
- (b) Surface.
- (c) Underground.

12. Car detectors.

13. Dragging equipment detectors.

14. Broken flange detectors.

15. Loose wheel detectors.

16. Hot bearing detectors.

17. Wires and cables.

18. Pipelines.

19. Conduits and supports.

20. Instrument and battery housings.

21. Foundations.

22. Heaters.

23. Painting.

24. Flood and other lighting.

25. Skates.

26. Inert retarders.

27. Rail and flange lubricators.

3. Specifications, standards, drawings, etc.

(a) Specifications, standards, drawings, etc., referred to in the body of this specification form an essential part hereof.

(b) Purchaser's drawings should include the following:

1. General plan of yard drawn to scale of not less than 1 in. equaling 100 ft., showing track arrangement and other features pertinent to the installation in accordance with AREA Manual Chapter 14--Yards and Terminals, Part 3-D.

2. Electric or pneumatic power mains, conduit or underground cable runs, power house, location of battery and

3. Specifications, standards, drawings, etc.--Continued.

transformer housings and wire terminal locations, type and limits of track circuits and such other features as are desirable.

3. Retarders and switches to be power-operated, with length and frog angle of switches.

4. Track and velocity head profile. (Fig. 3, AREA Manual Chapter 14--Yards and Terminals, Part 3-D.)

5. Rail section, drilling and switch layouts.

6. Control tower. Drawings, dated
.....

7. Power house, present or proposed, or both. Drawings, dated

8. Clearance diagrams.

9. Other standards and drawings including governmental regulations. Drawings, dated

(c) Contractor's drawings.

1. Contractor shall furnish with his proposal, drawings or references for the apparatus he proposes to furnish which are not covered by the drawings furnished by purchaser, and shall include typical circuits.

2. After the award of contract and before work is begun, contractor shall furnish for the approval of purchaser, the following:

(a) Track plan showing location of retarders, switches, signals, instrument housings, cable junction boxes, cable runs, etc., within days.

(b) Detail circuit plans, within days.

(c) Instrument case wiring plans, within days.

(d) Cable diagrams, within days.

(e) Pole line diagrams, within days.

(f) Location of main air line, air strainers, air dryers, including auxiliary reservoirs, valves, alcohol feeders, insulated unions, branch connections and expansion joints, within days.

3. After receipt of the drawings, purchaser will indicate any corrections that may be necessary, or signify his approval, within days.

4. Contractor shall be responsible for the correctness of all drawings furnished by him, although the drawings may have been approved by purchaser.

5. Any work done by contractor prior to the approval of contractor's drawings will be done at contractor's risk, unless previously authorized in writing by purchaser.

6. After contract is awarded, each party shall furnish the other, as required, prints of approved drawings.

3. Specifications, standards, drawings, etc.--Continued.

7. No change shall be made in any approved drawing without the written consent of purchaser.

8. After completion of contract, contractor shall designate on general plan the location of underground cable, main air line, air strainers, air dryers, auxiliary reservoirs, valves, branch connections and expansion joints.

9. After completion of contract, contractor shall furnish maintenance instructions and corrected tracings of drawings.

4. Furnished by purchaser.

(a) Purchaser will obtain necessary permits from governmental authorities.

(b) Purchaser will furnish, as indicated in paragraphs 4-c, d and e, material or labor, or both, on the following items:

1. Ties for support of apparatus.
2. Move ties as may be necessary.
3. Move switch and tie rods as may be necessary.
4. Insulated rail joints.
5. Bridge insulations.
6. Switch-rod insulations.
7. Tie-rod insulations.
8. Gage-plate insulations.
9. Concrete:
 - (a) Transit mixed.
 - (b) Mixed at site.
 - (c) Precast.
10. Necessary grading and drainage.
11. Excavating of solid rock.
12. Poles for line wire.
13. Crossarms, pins, transposition brackets, insulators, and fittings.
14. Line wire.
15. Battery housings.
16. Cables:
 - (a) Aerial.
 - (b) Underground.
17. Conduit:
 - (a) Main.
 - (b) Branch.
18. Make alterations of any part of existing structures or apparatus.
19. Prior to installation, furnish stakes establishing grade of track where required. (Fig. 3, AREA Manual Chapter 14--Yards and Terminals, Part 3-D.)
20. Rail welding, where required.

4. **Furnished by purchaser.** --Continued.

- 21. Track bonding.
- 22. Gage plates.
- 23. Manholes.
- 24. Sand, clay or loam.
- 25. Buildings including conduit and wire chases.
- 26. Communication systems.
- 27. Lighting:
 - (a) General.
 - (b) Flood.

- 28. Power supply.
- 29. Heating and air conditioning.

30. Unload and properly house materials that arrive on the ground before contractor's force; this work to be done under the supervision of contractor's representative.

- 31. Distribute material furnished by purchaser.

(c) Material only on items

(d) Labor only on items

(e) Material and labor on items

(f) Purchaser will furnish the items as indicated in paragraphs 4-c, d and e, subject to inspection of contractor, who shall state any objections thereto before starting his part of the work. After rectification by purchaser of any defects reported, contractor shall assume full responsibility for the proper functioning of the installation. The intent of this section is to bar any claim by contractor that the work done by purchaser has not been performed in such manner as to enable him to fulfill all the provisions of the contract.

5. **Alternates.**

(a) The provisions contained in the alternate requisites section of this specification form a part hereof only when substituted by purchaser's order for the provisions contained in this specification.

(b) Where blanks have not been filled, or where an option is permitted and no preference stated, contractor's recommended practice shall be followed.

6. **Shipment of material.**

(a) Material shall be shipped to, care of, marked for Material shipped from contractor's factory at shall be shipped via and thence via to destination.

7. Transportation.

(a) Purchaser will furnish transportation for men, necessary for the installation, over the following lines (*R-7-a):

1.
2.

(b) Purchaser will furnish transportation for tools and material, necessary for the installation, over the following lines (*R-7-b):

1.
2.

8. Inspection of installation.

(a) Contractor shall advise purchaser days in advance of the time installation will be completed and ready for final inspection. Purchaser will make inspection and tests within days after completion of the work.

9. Tests.

(a) Contractor shall make such tests as may be necessary to demonstrate, to the satisfaction of purchaser, that the apparatus, as installed, is in accordance with the requirements of the specifications and contract. These tests, unless otherwise specified, shall include the tests shown in paragraph 9-b and shall be conducted in accordance with AAR Signal instructions for testing, where applicable, otherwise as directed by purchaser. Contractor shall provide such instruments and apparatus, except cars, as may be necessary for making tests. Instruments and apparatus shall remain the property of contractor.

(b) The following tests shall be made:

1. General.

(a) Determine that all circuits conform to approved circuit plans by individually electrically checking each contact selection.

(b) Determine that the electrical operating characteristics of all electrically-operated devices are in accordance with manufacturer's specifications.

2. Insulation.

(a) Determine that the insulation resistance for each complete circuit except battery and common connections is not less than 1 megohm between conductors and to ground.

* Alternate Requisites section.

9. Tests.--Continued.

3. Car retarders.

(a) Determine that retarders follow the position of the control units in the control tower and that adjustments are in accordance with manufacturer's specifications.

4. Switch mechanisms.

(a) Determine that switches follow the position of the control unit at the control point.

(b) Determine that switch point indicator will not indicate normal or reverse position when switch points are open 3/9 in. or more.

(c) Determine that electric switch motor is snubbing properly.

(d) Determine that electric switch clutch is properly adjusted.

(e) Determine that trailable feature is operating properly.

(f) Determine proper operation of switches at prescribed minimum air pressure or operating voltage and that the time from the throwing of the controlling switch lever to the completion of the switch movement shall, under normal operating conditions, occur in not more than 1.2 seconds. *R-9-b-4-f.

(g) Determine that switches will return to original position if unable to complete stroke.

5. Control machine.

(a) Determine that all positions of levers correspond with proper positions of devices on the ground.

(b) Determine that control contact adjustments conform to approved plan.

6. Track circuits.

(a) Determine that track circuits have been installed and adjusted in accordance with approved plans and specifications.

7. Voltage.

(a) Determine that voltage for all apparatus is in accordance with manufacturer's specifications.

8. Air line.

(a) Determine that air distribution system is such that leakage in any section of the system will not exceed 1 lb. per sq. in. in 3 minutes from normal pressure with all apparatus connected and at rest.

* Alternate Requisites section.

10. Placing in service.

(a) After receipt of written authority from purchaser, contractor shall place the installation in service under supervision of purchaser, and shall leave competent men on duty for days thereafter. *R-10-a.

(b) Signal aspects shall be displayed or changed only as authorized by purchaser.

11. Completion.

(a) When installation is completed, apparatus and surface of the ground which has been affected by the installation, shall be left in a neat and clean condition.

12. Clearances.

(a) Clearances shall conform to clearance diagram furnished by purchaser.

Detail Provisions

13. Power supply.

(a) Purchaser will furnish volts d-c or volts a-c, cycles, phase at points as shown on Drawing, dated, and of sufficient capacity to operate the plant properly.

14. Air compressors and associated equipment.

(a) The following items shall be furnished by contractor (*R-14-a):

1. Compressors with capacity to provide for the maximum demand.

(a) Air compressors shall be electric motor driven, (one stage), with a capacity of cu. ft. delivery free (compound) air per minute, designed for air pressure of lbs. per sq. in. Motors shall be in accordance with IEEE Standards.

2. Standby compressor unit identical with paragraph 14-a-1-a.

3. An air strainer, approved by purchaser, installed in each air intake pipe.

4. Automatic governors as required.

5. Air dryers as required.

* Alternate Requisites section.

14. Air compressors and associated equipment. --Continued.

6. Interchange control panel for operating any compressor from any governor.

7. Starting and protective apparatus, as approved by purchaser.

(b) Foundations for compressors shall be provided by purchaser.

15. Generator.

(a) Alternating current generator shall be of kv-a, capacity at frequency, volts, phase, and shall be in accordance with IEEE Standards.

(b) Direct current generator shall be of kw, capacity at volts, and shall be in accordance with IEEE Standards.

16. Motor.

(a) Motor shall be h.p. capacity at frequency, volts, phase a-c; or volts d-c, and shall be in accordance with IEEE Standards.

17. Motor-generator.

(a) Motor-generator shall be direct-connected, mounted on a cast-iron or arc-welded steel fabricated subbase. *R-17-a.

18. Transformers.

(a) Oil-cooled transformer shall be in accordance with Manual Part 165.

(b) Air-cooled transformer shall be in accordance with Manual Part 164.

(c)

19. Rectifiers.

(a) Rectifiers shall be of type(s).

(b) Rectifiers shall be in accordance with the following specifications, where applicable:

1. Copper-Oxide Rectifier, Manual Part 139.

2. Selenium Rectifier, Manual Part 243.

3. Tantalum Rectifier, Manual Part 47.

4.

20. Batteries.

(a) Batteries shall be of type(s).

(b) Batteries shall be in accordance with the following specifications, where applicable:

1. Nickel, Iron, Alkaline Storage Battery, Manual Part 15.

* Alternate Requisites section.

20. Batteries.--Continued.

2. Lead Acid Stationary Storage Battery (Plates of Pure Lead), Manual Part 19.

3. Lead Acid Stationary Storage Battery (Plates of Alloy Composition), Manual Part 117.

4. Lead Acid Stationary Storage Battery (Plates of Composite Structure), Manual Part 18.

5. Type "A" Copper-Oxide Caustic Soda Primary Cell, Manual Part 6.

6. Type "B" Copper-Oxide Caustic Soda Primary Cell, Manual Part 4.

7. Air Depolarized Primary Cell (Renewable Type), Manual Part 16.

(c) Supports for batteries in buildings shall be furnished in place by the and shall conform to Drawing , dated

(d) Storage battery shall be charged to rated capacity by before placing in service.

(e) The shall furnish one hydrometer and one battery thermometer with each set of main battery.

(f) Installation of various types of batteries shall be in accordance with Instructions for Batteries and Cells, Manual Parts 14 and 7, respectively.

21. Switchboards and equipment.

(a) Switchboards and equipment shall be in accordance with Specification for Switchboard and Equipment, Manual Part 153. *R-21-a.

(b) Contractor's recommended arrangement of circuits shall be followed, subject to modification, to meet purchaser's special requirements.

22. Condensers.

(a) Condensers shall be of the atmospheric type. *R-22-a.

(b) Condensers shall be located as close to the compressor as practicable. They shall have a radiating surface of at least 1 sq. ft. per cubic foot per minute of compressor air demand. Condensers shall be in accordance with specifications and shall be furnished by and installed by

23. Air reservoirs.

(a) Auxiliary air reservoirs for collection of condensation shall be furnished and installed, as required, for condensers, for each low spot in the main air pipe and at such other locations as shall be designated by purchaser. Each reservoir shall be equipped with stop cock and blow-off pipe extending from bottom of reservoir.

* Alternate Requisites section.

23. Air reservoirs. --Continued.

(b) Extra large reservoirs called expansion tanks shall be used to provide a standby air supply. These reservoirs shall be properly equipped for drainage. *R-23-b.

(c) All reservoirs shall be designed for 200 lbs. per sq. in. working pressure and manufactured and tested in accordance with ASME Code for Unfired Pressure Vessel.

24. Air pipelines.

(a) Air lines shall be of extra strong, galvanized steel pipe in accordance with ASTM current Specification A 120 and free from zinc oxide or other foreign material that may scale off. *R-24-a.

(b) Each length of pipe larger than 3/4 in. diameter shall be provided with two metallic thread protectors and one extra heavy galvanized recessed coupling, shipped separately in boxes. Pipes of 3/4 in. diameter or less may be shipped in bundles with one end protected with heavy burlap and the extra heavy galvanized recessed coupling turned on the pipe hand tight.

(c) Fittings.

1. Fittings (elbows, unions, valves, etc.) around the compressor plant and in pits that are accessible for inspection, maintenance, etc., shall be for at least 200 lbs. working pressure.

2. Fittings that are buried shall be AAR Mechanical Division type for 300 lbs. working pressure.

3. Gate valves shall have brass seat and rising stem. *R-24-c-3.

4. Stop cocks and screw unions for 3/4 in. pipe and smaller shall have brass seats. *R-24-c-4.

5. Flexible connections shall be best quality 1-1/2 in. reinforced or armored hose for retarders and 1/2 in. for switch or skate mechanisms having 3 in. nipple inserted and securely fastened in each end and having not less than 16 in. of hose between the ends of the nipples. Complete connection shall be capable of withstanding a working pressure of at least 200 lbs. per sq. in.

6. Branch air line shall be taken from the top of the main air line, the connection being made by means of two street or service "L's" so arranged as to form a hinged joint to provide for expansion or by means of flexible hose.

7. Expansion joints for pipes 2 inches in diameter or larger shall have an iron body, a brass or iron sleeve and allowance for 6 in. expansion. *R-24-c-7.

24. Air pipelines, --Continued.

8. Expansion joints shall be placed in the main air line not more than 500 ft. apart where pipe is located above ground and 1500 ft. where pipe is located underground.

*R-24-c-8.

9. Main air line, when above ground, shall be securely anchored midway between each pair of expansion joints and at ends of line.

10. Each branch line shall contain a brass cock and union, at or near its connection with the main and if underground shall be adequately protected and accessible.

11. Check valves shall be installed in main air line as designated by purchaser.

12. Approved type of air filter shall be installed between each branch line and pneumatically-operated unit.

*R-24-c-12.

(d) Main air line shall be in good surface and so graded that condensation will run into suitable drain tanks. Main reservoirs shall be connected in series with the main air line and be provided with bypass of the same size as the main air line. Flanges, unions, gate valves, etc., shall be provided so that main reservoirs may be removed without interrupting the flow of air through the bypass.

(e) Pipe line installed in clean sand or gravel shall have no special protection. *R-24-e.

(f) Pipe line installed in cinder or slag ballast shall be wrapped with approved tape and surrounded by 4 in. of sand or loam.

(g) Air line when placed above the ground parallel to the track shall not be placed nearer than 6 ft. from the gage side of the rail, except by permission of purchaser.

(h) Local conditions shall determine the height of the main air line when above ground but in all cases the bottom of the pipe shall be not less than 6 in. above the top of the ground, except by permission of purchaser.

(i) Supports for main air line shall be placed not more than 10 ft. apart.

(j) Red lead, graphite or equivalent shall be applied to the pipe threads and only after pipe connections have been started when pipe is coupled.

(k) Each length of pipe and the fittings shall be free from dirt and scale before being coupled in the line, and care shall be exercised that no dirt gets in the line at any time. Pipelines shall be blown out before being connected to any apparatus.

*Alternate Requisites section.

24. Air pipelines. --Continued.

(1) Galvanizing shall be in accordance with Specifications for Metallic Coating of Metals, Manual Part 63.

25. Control machine.

(a) Control machine shall be in accordance with Manual Part 251.

26. Communication systems.

(a) Communication systems shall be in accordance with AAR Communication Manual.

(b) Communication systems shall be installed as specified by purchaser.

27. Foundations.

(a) Foundations shall be rigid and level.

(b) Elevation and distance of foundations from track shall be in accordance with purchaser's standard practice.

(c) Dimensions of concrete foundations shall conform to Drawing, dated

(d) Concrete foundations shall be allowed to properly set before any apparatus is connected thereto or placed thereon.

(e) Foundations shall be so constructed that apparatus can be removed without disturbing foundations.

(f) Purchaser and contractor shall jointly decide when deviations from specified sizes are necessary.

28. Anchor bolts.

(a) Anchor bolts for ground mast signals shall conform to Drawing 1107 or 1259.

(b) Anchor bolts for other foundations shall be in accordance with purchaser's standard.

(c) Threads of anchor bolts shall not be imbedded in concrete foundations.

(d) Bolt holes in base castings shall be filled with water-proof and rust-resisting compound.

29. Concrete.

(a) Concrete shall be 1-2-4 mixture and in accordance with AREA Manual Chapter 8--Masonry, Part 1. *R-29-a.

30. Car retarder.

(a) Car retarder shall be in accordance with Manual Part 253 or 254.

*Alternate Requisites section.

30. Car retarder. --Continued.

(b) Inert or weight-responsive retarders shall be in accordance with purchaser's specifications.

(c) Car retarders shall be designed to handle cars of tons gross weight axles with wheel diameters at a cutoff speed of miles per hour and shall be capable of retarding such cars in accordance with velocity head profile shown on purchaser's drawing.

31. Switch operating mechanism.

(a) Switch operating mechanism shall be in accordance with Manual Part 182.

32. Retarder controls.

(a) Manual control shall provide pressure positions and shall take precedence over other control if provided.

(b) Semiautomatic retarder control shall provide pre-selected exit speeds from retarders.

(c) Automatic retarder control shall provide for exit speeds from retarders for adequate car travel and proper coupling speed based on:

1. Car weight.
2. Car rolling resistance.
3. Distance to coupling.
4. Track characteristics.
5.

33. Switch fittings.

(a) Gage plates and rail braces shall be in accordance with purchaser's specifications.

(b) Switch operating rods shall be in accordance with purchaser's specifications.

(c) Arrangement and support of connections shall be such that switch points can be stopped by placing an obstruction between point and stock rail at any point of the stroke, without breaking or bending any such connections.

34. Skates.

(a) Number and type of skates shall be as specified by purchaser.

35. Signal system.

(a) Hump signals shall be as specified by purchaser.

35. Signal system. --Continued.

- (b) Hump repeater signals shall be as specified by purchaser.
- (c) Trimmer signals shall be as specified by purchaser.
- (d) Switch signals shall be as specified by purchaser.
- (e) Cab signals shall be as specified by purchaser.
- (f) Audible signals shall be as specified by purchaser.
- (g) Controls for hump and trimmer signals shall be provided as specified by purchaser.
- (h) Indicator lights repeating hump and trimmer signal indications shall be provided as specified by purchaser.
- (i) A track circuit shall be provided approaching the hump to interlock between the hump and trimmer signals as specified by purchaser. *R-35-i.

36. Track occupancy detection.

- (a) Detector track circuits shall be provided as shown on Drawing, dated and as specified by purchaser.
- (b) Clearance track circuits shall be provided as specified by purchaser.
- (c) Car location track circuits shall provide indication of distance to coupling as specified by purchaser.
- (d) Presence detectors shall be provided as specified by purchaser.

37. Switch control.

- (a) Manual control shall be provided for each switch as designated and shall take precedence over automatic control if provided.
- (b) Automatic switching shall be provided. *R-37-b.
 - 1. Automatic switching shall be so arranged that switches operate automatically to route cut to a selected track. The system shall provide storage and indication for routes.
 - 2. Program switching shall be so arranged that routes will be stored and routes indicated.
 - (a) Means shall be provided to cancel stored information and insert new destinations as required before reaching first automatic controlled switch.
 - (b) Means shall be provided to simulate movement of cuts through automatic switching limits.

* Alternate Requisites section.

37. Switch control. --Continued.

(c) Means for the selection of routes shall be provided at the hump. *R-37-c.

(d) Code storage and transfer.

1. Storage shall be provided to indicate routes for cuts leaving the crest of the hump.

2. At each switch other than the first automatically controlled switch after leaving the hump, there shall be provided as many storages as the maximum number of cuts that can be between that switch and the switch that precedes it during maximum rate of humping, as specified.

38. Test panel.

(a) Test panel shall be provided with a track diagram equipped with storage indication lights showing switch position and track occupancy.

(b) Lights to indicate light, medium, heavy and extra heavy relative car weights shall be provided.

(c) An indication showing destination of the next cut approaching switch shall be provided.

(d) A switch shall be located at each turnout to permit de-energizing track relays in sequence to simulate the movement of cars, and check operation of automatic route selection of switch machine.

39. Special circuits.

(a) The special circuit requirements, in detail, shall be as specified by purchaser.

40. Wires and cables.

(a) Wires and cables shall be in accordance with the following specifications (*R-40-a):

1. Galvanized Steel Strand, Manual Part 184.
2. Line Wire, Manual Part 173.
3. Insulated Wire, Manual Part 186.
4. Stranded Aluminum Line Wire, Manual Part 24.
5. Braid-Covered Cable, Manual Part 25.
6. Lead Sheathed Cable, Submarine, Manual Part 26.
7. Lead Sheathed Cable, Non-Armored, Manual Part 28.
8. Lead Sheathed Cable, Armored, Manual Part 20.
9. Neoprene Sheathed Cable with Outer Covering,

Manual Part 36.

* Alternate Requisites section.

40. Wires and cables. --Continued.

10. Shielded wire, as required, shall be as specified by purchaser.

11.

(b) In cables, spare wires shall be provided as designated by purchaser.

(c) Manufacturer's designation, size, description of circuit conductors, insulation and jacket shall be as specified by purchaser for the following:

1. Track transformers or batteries to rail.
2. Relay to each rail.
3. Fouling shunt connections.
4. Series track connections.
5. Switch circuit controller shunt connections.
6. Presence detectors.
7. Line drops.
8. Power line drops.
9. Signal controls.
10. Switch controls.
11. Ground.
12. Signal lighting.
13. Inside housings.
14. Aerial line.
15. Transmission lines.
16. Retarder controls.
17. Relay leads.
18. Aerial cables.
19. Underground cables.

41. Size of wire.

(a) Wire shall be of sufficient size to permit operation of car retarder, switch and signal operating mechanisms in accordance with this specification.

(b) Single-conductor wires external to the control tower shall be not smaller than No. AWG. Single-conductor wires within the control tower shall be not smaller than No. AWG.

(c) Wires in cable external to the control tower shall be not smaller than No. AWG.

(d) Line wires shall be not smaller than No. AWG for hard-drawn copper or No. AWG for copper-covered steel.

42. Wiring.

(a) Wiring shall be in accordance with Instructions for Wiring, Manual Part 84.

42. Wiring.--Continued.

(b) Lead cable, used underground, shall be mechanically protected as specified by purchaser.

(c) Equipment racks for the system shall be factory wired complete with inter-rack wiring. Wiring shall be checked at the factory and properly tagged for shipment. *R-42-c.

43. Overload devices.

(a) Circuit breakers and fuses shall be furnished by the contractor and installed according to contractor's practice, subject to approval by purchaser. *R-43-a.

(b) Circuit breakers and fuses outside of buildings shall be enclosed in weatherproof housings.

(c) Fuse clips shall be mounted on a base of fire-resisting and waterproof insulating material of high dielectric and mechanical strength.

44. Bonding.

(a) Track circuit bonding shall be type, and installed in accordance with Manual Part 22.

45. Relays.

(a) Relays shall be as specified by purchaser.

(b) Relays shall be in accordance with the following specifications, where applicable:

1. Tractive armature d-c neutral relays shall be in accordance with Manual Parts 101 and 123.

2. Tractive armature d-c polarized relays shall be in accordance with Manual Part 137.

3. Tractive armature d-c neutral relays, plug-in type, shall be in accordance with Manual Part 77.

4. Alternating current relays shall be in accordance with Manual Parts 53 and 122.

(c) Relays shall be provided with spare contacts where practicable.

(d) Non-vital plug-in relays and plug-coupled storage units shall be in accordance with contractor's recommendations.

46. Reactors and resistors.

(a) Reactors shall be in accordance with Manual Part 121.

(b) Resistors shall be in accordance with Manual Part 135.

* Alternate Requisites section.

47. Circuit controllers.

- (a) Switch circuit controllers shall be in accordance with Manual Part 49. *R-47-a.
- (b) Switch circuit controller connections shall conform to Drawings 1255, 1256, 1271 and 1272. *R-47-b.
- (c) Switch circuit controllers shall be connected to the near switch point.
- (d) circuit controllers shall be in accordance with

48. Lightning arresters.

- (a) High-voltage arresters, type, shall be in accordance with IEEE requirements and shall be installed as shown on circuit drawings.
- (b) Low-voltage arresters, type, shall be in accordance with Manual Part 95, and shall be installed as shown on circuit drawings.
- (c) Arrester grounds shall be in accordance with Manual Part 92. Contractor's liability is limited to grounding elements per ground.

49. Bootlegs.

- (a) Bootlegs shall conform to Drawing, dated

50. Track circuit connectors.

- (a) Track circuit connectors shall conform to Drawing 1632. *R-50-a.

51. Junction boxes.

- (a) Junction boxes shall conform to Drawing, dated
- (b) Junction boxes shall be located as shown on Drawing, dated

52. Terminal boxes.

- (a) Terminal boxes shall conform to Drawing, dated

53. Conduits.

- (a) Conduits shall be in accordance with AAR Communication Manual.

* Alternate Requisites section.

54. Wire chases.

(a) Wires within the control tower shall be in conduit or chase of fireproof construction. Provision shall be made by purchaser in the control tower walls and floors for proper housing of all wires between machine and equipment racks and between terminal boards and outside of the control tower. Wire chase in the equipment room for carrying inter-rack wires shall be furnished as specified by purchaser.

55. Line material.

(a) Crossarms and pole line hardware shall be in accordance with AAR Communication Manual.

(b) Insulators for distribution system shall be of
... type, material.

(c) Insulators for low-voltage circuits shall be of
... type, material.

(d) Pin type porcelain insulators shall be in accordance with Specifications for Pin Type Insulators, Manual Part 160.

56. Instrument housings.

(a) Instrument housings shall conform to the following drawings or references:

1.

57. Battery housings.

(a) Concrete battery boxes shall conform to Drawings 1266, 1267, 1268 and 1269.

(b) Steel battery boxes shall conform to Drawings 1520 and 1522.

(c) Battery boxes shall conform to Drawing, dated

58. Insulated rail joints.

(a) Insulated joints shall be type and for
..... section, lb. rail with hole drilling.

(b) Insulated joints shall be installed in accordance with Instructions for Insulated Rail Joints, Manual Part 133.

59. Switch-rod insulation.

(a) Switch-rod insulation shall conform to Drawing 1055.

*R-59-a.

*Alternate Requisites section.

60. Fibre insulation.
 (a) Fibre insulation shall be in accordance with Manual Part 58.
61. Painting.
 (a) Painting shall be in accordance with Instructions for Painting, Manual Part 110.
62. Padlocks.
 (a) Purchaser's padlocks shall be furnished by
 and shall be used where specified.
63. Computers.
 (a) Computers shall be in accordance with contractor's recommendations. *R-63-a.
64. Weight detector.
 (a) Weight detector shall be in accordance with contractor's recommendations.
65. Wheel detector.
 (a) Wheel detector shall be:
 1. Magnetic type.
 2. Electronic type.
 3. Track treadle type.
 4.
66. Radar.
 (a) Radar frequency shall be MHz.
67. Yardmaster car counter.
 (a) Yardmaster car counter shall be as specified by purchaser.
68. Dragging equipment detector.
 (a) Dragging equipment detector shall be as specified by purchaser.
69. Hot bearing detector.
 (a) Hot bearing detector shall be as specified by purchaser.
70. Broken flange detector.
 (a) Broken flange detector shall be as specified by purchaser.

* Alternate Requisites section.

71. Loose wheel detector.

(a) Loose wheel detector shall be as specified by purchaser.

72. Rail and flange lubricators.

(a) Rail and flange lubricators shall be as specified by purchaser.

Alternate Requisites.

R-7-a.

Contractor will furnish transportation for men, necessary for the installation, over the following lines:

1.
2.

R-7-b.

Contractor will furnish transportation for tools and material, necessary for the installation, over the following lines:

1.
2.

R-9-b-4-f.

Determine proper operation of switches at prescribed minimum air pressure or operating voltage and that the time from the throwing of the controlling switch lever to the completion of the switch movement shall, under normal operating conditions, occur in not more than seconds.

R-10-a.

Purchaser will place the installation in service in the event that he does not authorize contractor to do so within days after completion of the work to purchaser's satisfaction.

R-14-a.

The following items shall not be furnished by contractor:

1. Compressors.
2. Standby compressors.
3. Air strainers.
4. Automatic governors.
5. Interchange control panel.
6. Starting and protective apparatus.

Alternate Requisites. --Continued.

R-17-a.

Motor-generator shall not be direct-connected.

R-21-a.

Switchboard shall be in accordance with

R-22-a.

Condensers shall be of the type.

R-23-b.

Extra large reservoirs called expansion tanks to provide a standby air supply shall not be used.

R-24-a.

Air lines shall be of extra strong, galvanized wrought iron in accordance with ASTM current Specification A 72 for underground service, and extra strong, galvanized steel pipe in accordance with ASTM current Specification A 120 for service above ground and free from zinc oxide or other foreign material that may scale off.

R-24-c-3.

Gate valves shall have

R-24-c-4.

Stop cocks and screw unions for 3/4 in. pipe or smaller shall be

R-24-c-7.

Expansion joints for pipes 2 inches in diameter or larger shall have

R-24-c-8.

Expansion joints shall be placed in the main air line not more than ft. apart where pipe is located above ground and ft. where pipe is located underground.

R-24-c-12.

Air filter shall not be furnished.

R-24-e.

All pipe shall have approved protection.

Alternate Requisites. --Continued.

R-29-a.

Concrete shall be mixture in accordance with
Specification, dated

R-35-i.

A track circuit shall not be provided approaching the
hump to interlock between the hump and trimmer signals.

R-37-b.

Automatic switching shall not be provided.

R-37-c.

Means for selection of routes shall not be provided for
at the hump.

R-40-a.

Wires and cables shall be in accordance with
.....

R-42-c.

Equipment racks for the system shall be factory wired
complete with plug-coupled inter-rack wiring. Wiring shall
be checked at the factory and properly tagged for shipment.

R-43-a.

Circuit breakers and fuses shall be furnished and installed
as follows:
.....

R-47-a.

Switch circuit controllers shall be

R-47-b.

Switch circuit controller connections shall conform to ...
.....

R-50-a.

Track circuit connectors shall conform to Drawing
..., dated

R-59-a.

Switch-rod insulation shall conform to Drawing,
dated

R-63-a.

Computers shall be as specified by purchaser.

Exhibit 10-B

(Revised Signal Manual Part 59)
AAR SIGNAL REQUISITES

TRACK CIRCUITS

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for track circuits. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. Track circuits shall be so designed that track relay will be in de-energized position if, when track circuit is dry, a shunt of 0.06 ohm resistance is connected across the track rails of the circuit, including fouling sections of turnouts.*

3. Track circuits shall be so designed and connected that the track relay will be in the de-energized position whenever any of the following conditions exist:

(a) A rail is broken or rail or switch frog removed, except when rail is broken or removed in the shunt fouling circuit of turnout or crossover, or when break occurs between the end of rail and track circuit connector or within the limits of rail-joint bond, appliance or other protective device.

(b) A train, engine or car occupies any part of a track circuit including the fouling section of turnouts and crossovers, except turnouts of a hand-operated main track crossover protected by other means than track circuits.

(c) Where switch shunting circuit is used:

1. Switch point is not closed in normal position.

2. Switch is not locked where facing point lock with circuit controller is used.

3. Independently-operated fouling point derail equipment with switch circuit controller is not in derailing position.

4. Track circuit fouling protection shall conform to Form 7004, Manual Part 206.

5. Bonding shall be in accordance with Manual Part 22.

*See Formulae for Computing Minimum Allowable Resistance between Track Battery and Track and for Computing Related Current and Voltage Data, Manual Part 132.

6. Where relayed cut-section is used with non-coded direct current track circuits, the track relay at such cut-section shall, when in de-energized position, open the energy supply for and shunt the adjoining track circuit.

7. At grade crossing with an electric railroad, the electric energy for non-coded direct current track circuits shall feed away from the crossing.

8. Each track circuit, except where impracticable due to special conditions, and where single-rail track circuits are used, shall be insulated from all adjoining track circuits and from all non-track-circuited track.

9. The length of any section of a track circuit used for control of signal facilities which affects safety of train operation shall be greater than the maximum inner wheel base of any engine or car except when protected by trap or special circuit.

10. In electrified territory where double-rail track circuits are used, the maximum length of track circuits shall be not greater than will provide a safe margin of broken-rail protection with the ballast leakage and spacing of traction cross-bonding that obtains.

11. Where dead section exceeds 35 ft., or the shortest outer wheel base of an engine operating over the dead section, special circuit shall be installed.

12. Location of insulated joints shall conform to Drawing 1634, 1635, 1636, 1637 or 1638, whichever is applicable.

13. The relays of coded track circuits on tracks signaled in one direction only and effective relay for selected direction on tracks signaled in both directions, should be at the entering end of the circuit.

14. Shunt wires and fouling wires, except shunt wires to switch circuit controller through which signal control circuits are controlled and track circuits are shunted, shall consist of at least two conductors and each shall be of sufficient conductivity that the track relay will be in de-energized position when the circuit is shunted.

15. In direct current track circuit design for locations where foreign current may be present consideration shall be given to Instructions for Minimizing the Effect of Foreign Current on Direct Current Track Circuits, Manual Part 127.

Exhibit 10-C

(Revised Signal Manual Part 64)
AAR SIGNAL REQUISITES

MOVABLE BRIDGE INTERLOCKING

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for movable bridge interlocking. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.

2. Requisites for Interlocking, Manual Part 94, shall govern where applicable.

3. Signal devices shall be so interlocked with bridge devices that before a signal governing movements over the bridge can display an aspect to proceed, the bridge must be locked and the track aligned, with the bridge locking members within 1 in. of their proper positions, and with the rail on the movable span within $3/8$ in. of correct surface and alignment with rail seating device on bridge abutment or fixed span.

4. When used, machines for operating devices which check the surface and alignment of rails, check bridge locking mechanism, or operate bridge circuit controller shall indicate when movement is completed and unit is locked.

5. Signal devices shall be so interlocked with bridge devices that no bridge device can be operated unless all signal devices have properly functioned to release the bridge.

(a) To open movable span:

1. Home signals at Stop.
2. Devices for checking the surface and alignment of rail ends in proper position.
3. Movable bridge circuit controllers and pipe couplers open.
4. Bridge operating mechanism released.

(b) To establish rail traffic:

1. Bridge operating mechanism locked.
2. Movable bridge circuit controllers and pipe couplers closed.
3. Devices for checking the surface and alignment of rail ends in checking position.
4. Home signals clear.

Exhibit 10-D

(Revised Signal Manual Part 205)
AAR SIGNAL REQUISITES

ROCK FALL AND SLIDE DETECTION

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for rock fall and slide detection. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.
2. Detectors shall conform to Drawing 1505, 1506 or 1507 and be of the type, length and height required by local conditions.
3. Operation of detector shall be indicated for approaching trains or movements or to a remote point, or both.
4. Indication shall be maintained until reset.
5. Circuits shall be designed on the fail-safe principle.

Exhibit 10-E

(Revised Signal Manual Part 217)
AAR SIGNAL REQUISITES

DRAGGING EQUIPMENT DETECTION

1967

1. These requisites are for the purpose of setting forth the recommended general requirements for dragging equipment detection. They set forth specific detail requirements representing modern signal practice recommended for new installations and for replacement of existing installations when general renewal or replacement is to be made.
2. Detector system shall function to detect broken or misplaced train equipment which has dropped below a predetermined clearance line between rails or adjacent to outside of rails.
3. Operation of detector shall be indicated to the train or movement involved or to a remote point, or to both.
4. Indication shall be maintained until reset.
5. The apparatus shall, as far as practicable, be designed and circuits arranged on the fail-safe principle.
6. Detector shall be mounted so as to maintain a fixed relation with surface of rail.
7. Detector shall be so constructed and installed as to minimize the effects of ice or packed snow on its operation.
8. Detector parts designed to be broken by dragging equipment shall be readily replaceable.

Exhibit 10-F

CONTROLLED YARD SWITCHING SYSTEM

In 1966, a Southeastern Railroad installed a yard switching system to control 14 electro-pneumatic power switches and associated signals on a ladder track of a small flat classification yard.

The control panel is located in a small metal building adjacent to the lead track and is operated by the foreman of the crew performing the switching. Switches cannot be operated from control panel while detector track is occupied.

All electro-pneumatic power switches have a local control lever located adjacent to each switch. Trailing movements may be made through the power-operated switches.

ECONOMIC STATEMENT

1. Cost of Installation.
 - (a) Capital Investment \$ 43,350.
 - (b) Operating Expense 3,250.
 - Total \$ 46,600.
2. Gross Savings per Annum 35,570.
3. Increased Annual Operating Expenses 2,100.
4. Net Reduction in Annual Operating Expenses 33,470.
5. Deduction for Interest Charges @ 6% of \$43,350 .. 2,601
6. Net Savings per Annum 30,869.
7. Annual Return over 6% Interest:
 - (a) On Capital Investment $(30,869 \div 43,350)$... 71%
 - (b) On Total Cost $(30,869 \div 46,600)$... 66.2%

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